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ELECTRICITY AT THE LYONS EXPOSITION.

THE inventive efforts of the manufacturers of electric apparatus are being further and further directed toward improvements in details. In support of this assertion, we may mention the remarkable exhibit of Mr. Fabius Henrion, of Nancy, in whose dynamos are found a certain number of ingenious arrangements, and especially the lubricating devices, which will be spoken of further along.

This house exhibited at the Lyons Exposition the following machines and apparatus: (1) A dynamo of 900 amperes and 110 volts actuated by a horizontal 150 horse power engine (Fig. 1) and (2) a dynamo of 600 amperes and 110 volts actuated by a vertical 100 horse power engine (Fig. 3).

These machines serve to supply simultaneously various electric light and motive power circuits in the interior of the Exposition.

From a mechanical view point, they are very remarkable. The three pillow blocks are cast in a single piece with the frame. The wedging of the ring presents an absolute security. The electros are placed upon the lateral faces of the ring.

From an electrical view point, these machines have a very high rendering, say from 96 to 98 per cent., and this is due to the fact that the ring is completely utilized on both sides and that the magnetic circuit is but very slightly resistant.

The electros are of soft iron, as are also the polar plates. As the field is very intense, the machine, in case of a variation in velocity, furnishes a much more stable current than do those in which the electros are of cast iron. Moreover, the ring, being of wide diameter, forms a fly wheel (Fig. 4), and this also tends to render the current regular.

The machines are provided with lubricating pillow blocks (Fig. 5), certain of which, it is asserted, have operated for seventeen months without a renewal of the oil.

The arc lamp exhibited by Mr. Henrion is differential. It is represented in Fig. 6. The current that supplies it, traversing the coarse wire soleno, S, draws up the iron rod, A, and the arc forms. In measure as the arc elongates, the intensity of the current diminishes, and the soleno, S, allows the rod, S', to fall. The fine wire soleno, S', on the contrary, mounted in derivation at the terminals of the lamp, draws more powerfully the rod, B. The efforts of the two solenos therefore concur in the same direction to cause the carbons to approach. The rods are conical, so as to give an equal attraction at all points. This lamp is a true balance, which, at every instant, separates the carbons as well as causes them to approach each other, and it is so much the more sensitive in that the rods, being attracted simultaneously by the solenos, no longer bear upon the axes. One will, therefore, never find himself without a light, as with the mechanical lamps that form the arc but once.

There is no brake, no gearing to interfere with the free motion of the rods that is so useful for the rapid replacing of the carbons and putting them exactly opposite each other.

Fig. 2 gives a diagram obtained with one of these lamps.

Mr. Henrion also exhibited a very complete picture of apparatus, comprising quickly freed interrupters, an automatic tension regulator, and some measuring instruments. These latter apparatus operate through the action of a solenoid upon a thin sheet of metal. They give continuous indications.

The automatic regulator (Fig. 7) comprises a double ratchet capable of oscillating upon an axis passing through its center and to which is given, through a mechanical transmission, a to and fro motion upon two interdependent opposite toothed wheels; and a horizontal beam, F, carrying at one of its extremities a rod of soft iron which is attracted by a solenoid, S, mounted in derivation at the terminals of the dynamo. This attraction is balanced by a traveler, so that, during a normal running, the beam is always horizontal, and oscillates between two points, A and B. The beam is connected with one of the poles of the machine. If the tension varies, the attraction of the soleno, S, is more or less strong, and the beam abuts against A or B and causes a current to pass into one or the other of the electros, E E'.

The double ratchet attracted by one or the other of these electros tilts to the right or the left, and then acts upon one or the other of the two toothed wheels, which carry along a tappet fixed to their center and displace it upon the keys of a variable resistance placed upon the exciting circuit of the machine. This resistance is, therefore, regulated automatically, so as to keep the tension constant, despite the variations in velocity. This regulator permits of installing the electric light in establishments in which the motive power undergoes the greatest irregularities, such as in weaving works actuated by hydraulic motors, paper mills, etc.—*La Revue Technique.*

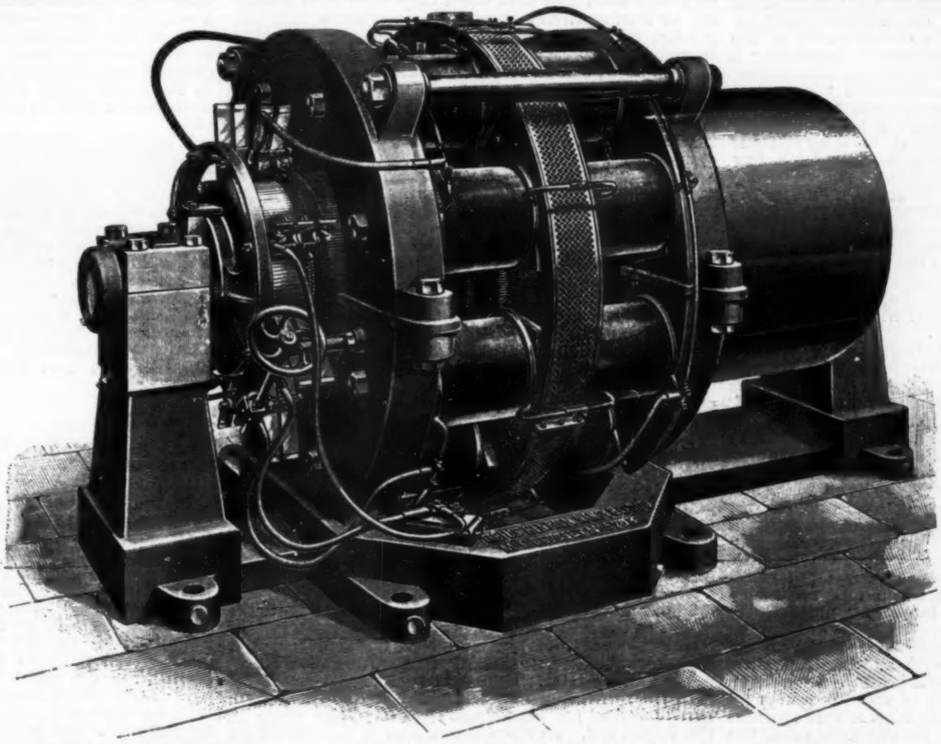


FIG. 1.—A 900 AMPERE AND 110 VOLT DYNAMO ACTUATED BY A 150 H. P. ENGINE.

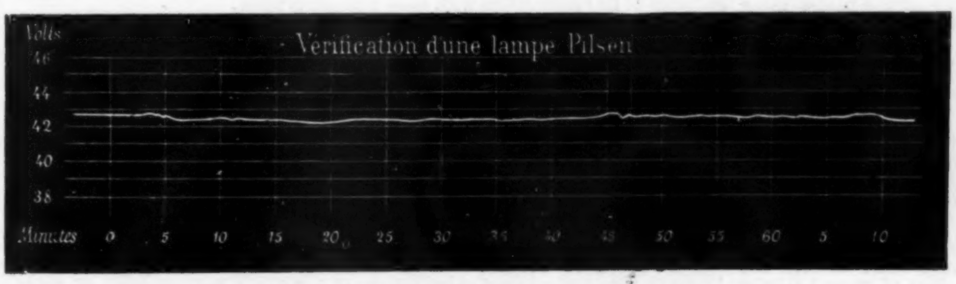


FIG. 2.—DIAGRAM TAKEN FROM A PILSEN LAMP.

FIG. 3.—A 600 AMPERE AND 110 VOLT DYNAMO ACTUATED BY A 100 H. P. ENGINE.

IMPROVEMENTS IN STORAGE BATTERIES.

By MAURICE BARNETT.

THE recent award by the Franklin Institute, of Philadelphia, to the inventor of the "chloride accumulator" is indicative

of the great commercial importance attached to the use of secondary batteries for storage purposes. That the recipient of the medal is a Frenchman is not strange, considering that France is far ahead of the United States in its application of accumulators to the users of central stations for electric lighting and traction work. In Paris alone twenty-one stations are supplied with these storage cells (containing 760 tons of plates) which run 120,000 lamps. Paris has three lines of cars run by chloride accumulators, while the same system is in use at Cannes, Boulogne sur Mer, Nantes, Clichy and other towns. Stimulated by the hope of reward from a new and increasing industry, French genius had been for a long time directed to this branch of electro-economics, with the result that a Frenchman's efforts produced the successful solution of electric storage. That is why the honor of the award of the Scott medal fell to foreign rather than to domestic genius.

Although electric companies in the United States have been backward in taking advantage of efficient secondary batteries as an adjunct of their generating systems, the recent placing by the Edison Company, of New York, of a large order for accumulators of the French type, is exceedingly suggestive, indicating a tendency to follow the example of foreign companies. The necessity for such accumulators in the central stations of electric lighting companies, for traction work and for large office buildings, is apparent after momentary consideration. In electric lighting stations it is found that during the winter months, for a few hours every night, the generating plant is loaded beyond its capacity, while during the summer months the load is carried easily. It is obvious that a simple generating plant must have a capacity equal to the maximum demand that may be made upon it. Furthermore, the day load at no time of the year is of sufficient importance to justify the expense of running. Inasmuch as day lighting is necessary, electric companies frequently run during that period at a loss to themselves.

It is here that the storage battery proves of great commercial value; for with the help of a secondary battery a generating plant does not need to have a capacity sufficient to satisfy the maximum demand, as a much smaller generating plant worked up to its full capacity in connection with a set of accumulators can store up its surplus output and make a requisition upon it during the hours of the day when the load is in excess of the capacity of the dynamos. Such storage batteries can carry the day load and furnish light on Sundays without the necessity of operating a power plant at those times. Besides the economy in wages and fuel, there is a great opportunity to lower the cost of installing a power and generating plant, as a small generating plant with the aid of secondary batteries can do the work of a large and more costly installation of generators alone. With regard to the lighting of large office buildings it has been the custom either to buy the light from electric lighting companies or to operate a dynamo plant and produce the light in the buildings themselves. Both of these practices involve a rather large tax upon the income of the owners of these office buildings, as, in the first case, the lighting company's charges are frequently excessive, and in the second case day and night help must be maintained. It is the experience of companies using storage batteries that they can have light every hour of the day, Sundays included, and get along with the help of one engineer. Lastly, the advantages of accumulators to electric railway plants would be obvious if for no other purpose than in saving the engines and dynamos from the great fluctuations of load so noticeable in these plants. In such cases a storage battery soon pays for its installation. If such a system is placed at suitable points along a railway line, considerable "feed wire" can be done away with, and a more even pressure of current maintained. These auxiliary plants act automatically, and require very little attention. Their value is most apparent when it is considered that a break in the supply circuits or a shutting down in the generators does not necessarily involve the stoppage of the cars. Installations of these batteries can be made to carry the whole load late at night and early in the morning, when few cars are running—the income from operating which by generators would not defray expenses. As an instance in which the application of electric accumulators to traction purposes has been crowned with commercial success may be mentioned the two lines of cars running from Paris into the suburb of St. Denis, the combined length of which is 11 miles. The power plant consists of three 150 horse power boilers, three 150 indicated horse power engines, and a number of dynamos of 250 volts and 300 amperes output each.

Each of the cars of the company is furnished with 108 storage cells designed especially for traction purposes, and of a capacity capable of running the car a distance of about 40 miles under the conditions of the severe gradients and curves along these lines. Considering that the gradients are frequently as high as 4 per cent., that the cars are intended to carry 50 persons, that the weight over all is 28,000 pounds, that 52 batteries of 5,616 cells and 61,776 plates perform an equivalent of 1,550 car miles daily, and that up to May 1, 1894, one million car miles had been run since accumulators supplied the motive power—the feasibility of using storage batteries for traction work is very apparent. The success attending the use of these batteries was so great that horse power was entirely superseded over a year ago, and a new line running from the Saint-Ouen town hall to Neuilly is now being supplied with the same type of accumulator.

Although theoretical and practical considerations affecting electric storage have long held out great promise to the inventor of an accumulator efficient under all the conditions to which it might be exposed, it has only been within a very few years that such a storage cell has been perfected. The cause of this is to be found in the fact that inventors have been led astray for a number of years by erroneous methods; and in trying to make the "pasted" battery meet the demands of modern engineering, have failed most signally. Of late years there has been a tendency to revert to the Plante type of battery, which has been improved by French genius until, in the modernized form of this battery, founded on correct mechanical and scientific principles, we have an accumulator of a very high grade of excellence.

The qualities that a good storage battery must have are:

First. Non-liability to mechanical disintegration after continued use or during rapid charges or heavy discharges.

Second. A large active surface for small weight of elements.

Third. Good contact between the active surface and the inclosing frame.

Fourth. Low internal resistance.

The old method of producing lead storage batteries was to phase the lead plates slowly by electrolysis until they had the required spongy condition. The later way is to cast a frame of lead, ribbed normally in two directions with square depressions between the ribs, or to punch a lead plate full of holes and fill these with a pasty mixture of red oxide of lead in positive plates and litharge in negatives.

Accumulators made in this way can hardly be said to possess, in a high degree, any of the four qualifications just mentioned. It is almost invariably noticeable with such cells that when they have been in long use or during heavy discharges mechanical disintegration of the plates takes place—shown by small fragments of lead and lead oxide falling down between the elements, short circuiting them and in many cases causing serious damage by producing either buckling, sulphating or both. This disintegration is evidently due to the fact that the lead oxide paste placed in these holes is a mechanical rather than a chemical compound, and that during the action of the cell the cohesion of the particles is ruptured by the change of volume attending chemical action. Furthermore, the process of cementing lead oxide paste into or against a lead frame in order to obtain the necessary active material will not produce the porosity and surface area which will give a maximum of capacity for a given weight and size of cell—a feature of great importance where storage cells are destined for traction purpose. Lastly, cells made in this way show a poor contact between the active substance and the lead frame. The result of this is increased internal resistance and heating, with consequent diminished output.

Some years ago, John Scott, of Edinburgh, gave the city of Philadelphia a sum of money, the interest on which was to be used for the encouragement of "ingenious men and women who make useful inventions." The legacy provides for the distribution of a medal inscribed "To the most deserving," and a money premium. The Board of City Trusts of the city of Philadelphia delegated to the Franklin Institute the power to examine inventions and award the Scott medal and premium. The investigations are made by the institute under the competent assistance of its "Committee on Science and the Arts," and recommends for the award all meritorious inventions.

The committee that was appointed to investigate the merits of the "Chloride Electric Storage Battery," or "Chloride Accumulator," handed in its report recently, and recommended the award of the John Scott premium and medal to Clement Payen, the inventor. Incidentally, mention was given Mr. Herbert Lloyd, of Philadelphia, for important improvements made in the Payen cell. As this accumulator is considered by the ablest electrical engineers in the country to mark an era in the history of electric storage batteries, a description of its construction with some comments upon its efficiency will doubtless be of value to any one interested in electrical science.

The method of construction of these cells would seem to make possible of production a secondary battery that would possess the important qualifications just mentioned, of non-liability to mechanical disintegration after continued use or during heavy discharges, a large active surface for small weight of elements, a good contact between the active material and the inclosing frames, combined with low internal resistance. The active material is obtained, not as in the old way by cementing lead oxide paste into a frame, but in a manner purely chemical. A mixture of the chlorides of lead and zinc, in certain proportions, is fused, and the product cast into pastilles in suitable moulds. When thus cast, the mixed chlorides are of a whitish color, vitreous character and very brittle. The pastilles to be used for negative plates are about ¾ inch in cross section and $\frac{5}{16}$ inch thick, and are cast in groups of four which are united by filaments from $\frac{1}{16}$ to ⅛ inch thick. The "positives" are cast separate—each one having a beveled V-shaped periphery. These pastilles are then placed in a suitable mould, and molten antimonial lead cast around them under high pressure. This feature of casting under pressure is one of the improvements due to Mr. Herbert Lloyd, and has been patented by him. The connecting sheets of the negative groups, the V-shaped bevel of the positives and the casting under pressure combine to make the fixation of the active matter exceedingly good. The frames alternating with zinc plates in metallic contact are then immersed in a bath of dilute zinc chloride. This arrangement acts like a primary battery that has been "dead short-circuited," with the result that the chemical changes which take place effect the removal of the zinc chloride. There is then left the dense frame of antimonial lead containing, now, pastilles of spongy lead, which are then "formed" in the usual manner.

This lead on examination is found to be crystallized in such a way that the longer axes of the crystals are regularly arranged normal to the surface of the plates. The advantage of this is that between the crystals there are spaces which permit the changes of volume, which occur from the action of the cells, to take place without producing lateral stresses upon the crystals or in any way causing their disintegration. Owing to this circumstance heavy discharges can take place without mechanical violence to the structure. Furthermore, the cohesion of the pastilles of this spongy lead, and consequently of the peroxide of the "formed plates," is very great; for it is well known that "in a crystalline form the molecules of matter are arranged in a different order from what they are in any mechanical mixture. In the mechanical mixture the aggregation of the atoms is strictly fortuitous; that is to say, it is a mere question of chance how they are arranged, and they have no cohesion among themselves beyond that which is given to them by the cementing mixture which holds them together. In the crystalline form, however, all this is changed; the molecules of the body are arranged in perfect symmetrical order, and they are held together by molecular affinities which regulate the order of their distribution and secure the coherence of the mass." In other words, the particles of this spongy lead and peroxide are bound together far more strongly than is possible in "forming" plates by the old method of mechanical mixture. Beyond this it is obvious that the peculiar structure of this spongy lead admits of a maximum active surface of uniform consistency through the entire plate—save where the antimonial lead frame intervenes. And as the capacity of a cell of given size and weight depends upon the amount of chemically active material the cell under discussion will require less floor space than other accumulators.

Although the construction just described seems thoroughly effective in preventing the tendency to disintegration, it has nevertheless been considered expedient, as a precautionary method solely, to introduce between the plates a thin sheet of woven asbestos cloth so that any small particles which might be detached could not short-circuit the cell. It is found that this asbestos increases the resistance of the cell to a very small extent—which is compensated for, however, by the fact that the contact in this accumulator is exceptionally good, owing to the shape of the chloride pastilles, and to the fact that they were cast in the frame under pressure. The internal resistance is no greater than in other lead cells, being about 0·002 ohm.

If the data were available, it would be exceedingly interesting to compare the relative capacities of the "chloride accumulator" with other storage cells manufactured in this country. Unfortunately, makers of strictly American types of secondary batteries have not published information regarding the capacity and efficiency of their cells. The only information at hand is a table of comparative capacities per pound of positive and negative plates, compiled by Hardman Arthur Earle, and covering only the French, German and English types. A glance at this table shows the status of the art in Europe and the position held by the chloride accumulator. The Crompton-Howell is the English type and the Tudor the German type of storage cell.

	Type of accumulator.	Rate of discharge. Small.	Normal.	Strong.	Maximum.
Capacity in ampere hours.	Chloride (Payen cell)	8·1	6·7	5·6	4·0
	Crompton-Howell ..		2·8	2·34	1·77
	Tudor..................	2·2	1·9	1·7	1·6

In conclusion it may be said that this battery is destined to play an important part in the economy of light and power installations. It is manufactured abroad by the Societe Anonyme pour le Travail Electrique des Metaux, of Paris, France, a company controlled by the Rothschilds, and by the Chloride Electrical Storage Syndicate, Limited, of Manchester, England, of which Dr. Edward Hopkinson is managing director. In this country the Electric Storage Battery Company, of Philadelphia, has undertaken its manufacture under the management of Mr. Herbert Lloyd, whose name was mentioned in connection with having taken out patents in the United States for improvements in the manufacture of the Payen cell and its adaptation to traction purposes.—Eng. and Min. Jour.

POSSIBLE IMPROVEMENTS IN THE SUPPLY OF ELECTRICAL ENERGY.

By S. Z. DE FERRANTI.

SEEING the position that the art of distributing electrical energy has attained, and remembering the stages through which it has gone, I think that it may be well to look ahead, and to endeavor to work out the directions in which progress must be made.

The whole essence of improvement lies in the cheapening of the supply to bring it within the reach of all, and to adapt it to the many purposes for which it is so admirably suited. If we wish to attain to this, we must not be led away by looking at the matter in a narrow light, or considering the question from the standpoint of what is best in the immediate future. We must consider the question on the broad lines of the supply of a large and scattered area, such as is presented by almost all our towns, and this object must be achieved without the complication of a number of generating stations, which are but a clumsy makeshift on account of our defective knowledge.

Of the two systems, viz., alternating high tension with transformation and low tension continuous direct supply, we have got to select that which meets the case most completely, and which gives the best promise of good results in the future. We must clearly not be misled by taking the system upon which it is easy to get the best results in the first instance, and which does not meet the real problem of electrical distribution.

Hitherto in this country the continuous and alternating systems have gone along side by side, though there is now a marked preponderance in the increase of the alternating. Usually the continuous current stations show better results in the way of cheapness of supply than the alternating current, and it is not hard to see that this should be so at the start. The continuous current stations have of necessity been put down in districts of small area, and in all respects suitable for electric lighting.

It stands to reason that to feed a small area it must be cheapest to do it by direct low tension supply, every transformation of energy, however perfect, involving some loss. As a result of this, we have had station after station laid down which is capable of extension, and systems have grown up which, until they are gradually changed, can never bring electric lighting, heating and power to the position they will surely attain. The shortsightedness of this policy appears to have been lost to many engineers in their desire to follow what has, in the first instance, paid best, and to give to their clients that which will make the most remunerative investment at first.

But the possibilities of the low tension system, even when increased to the voltage of the five-wire system, are very limited, and almost every town that has adopted low tension is even now looking for a way out. They cannot expect to make their business large enough to be really commercial, and the sites of their generating stations are usually cramped, and in the

worst and most expensive places for power generation.

Now, remembering our first point as to ultimate cost and its effect, let us see what is the first thing to be sought after to attain it.

The business of distributing electrical energy must be done upon a large scale to be commercial, and to attain this we must supply a large area not limited by the exigences of systems, and we must do this from a site not in the congested heart of a big city, but from a position best suited by its natural advantages to the carrying on of such an undertaking.

This points clearly to the supply of current at high tension, and as the energy must be delivered to the consumer at a low pressure, it also points to transformation in some form or other.

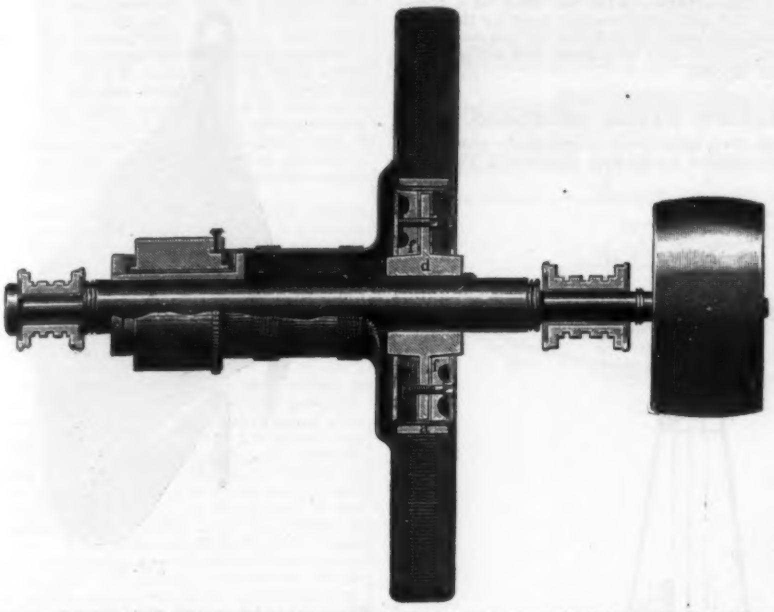


FIG. 4.—SHAFT OF THE DYNAMO WITH A RING FORMING A FLY WHEEL.

As regards the distribution of electrical energy, we are therefore brought face to face with the fact that the only system which can completely meet conditions absolutely necessary to eventual success is the alternating high tension one. But of course this system, as is well known, leaves much to be desired in certain directions.

Cables are now being manufactured, at moderate prices, capable of taking such high pressures that the question of the electromotive force used, from this point of view, is almost negligible. We have certainly succeeded most completely in transmitting high pressure currents by means of these cables, and there is little improvement which can be looked for in this direction. The only point where improvement is likely to be made is in using a voltage a good deal higher than that ordinarily used in present systems of electrical distribution, and I am quite satisfied that if the rest of the apparatus were capable of working well with a pressure of 5,000 volts instead of 2,000 or 2,500 volts, there would be no difficulty from the point of view of the cables, and that this increased pressure could be supplied through cables costing practically the same money for the same sectional area, and, therefore, meaning that the sum invested in cables would be good for delivering a much greater quantity of energy to the consumers.

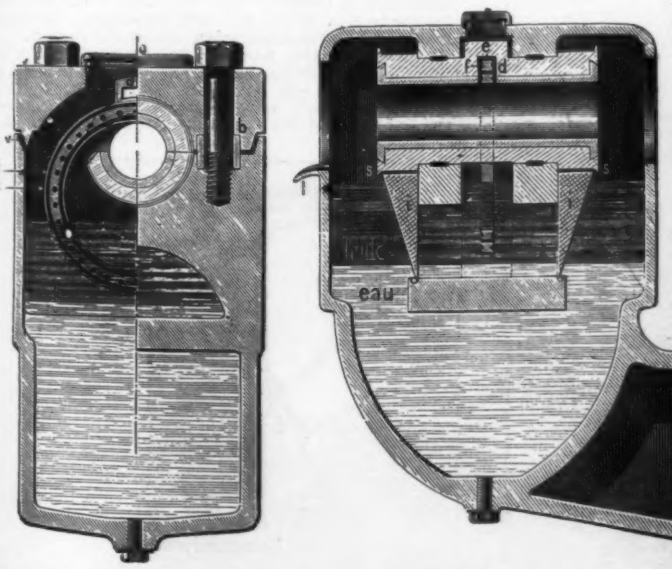


FIG. 5.—TRANSVERSE AND LONGITUDINAL SECTIONS OF THE LUBRICATING PILLOW BLOCK.

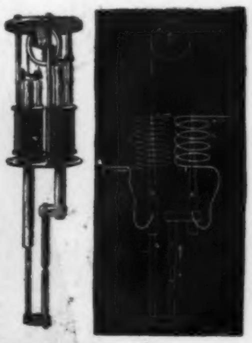


FIG. 6.—ARC LAMP.

We next come to the question of the transformers, and this, of course, is undoubtedly the one seriously weak point in the alternating high tension system. Great improvements have lately been made in the manufacture of transformers, but it is principally in this direction which we must still look for improvement, both as regards manufacture, reduced maintenance, and a much greater percentage of energy sold than is at present possible. There is no reason why transformers should not be so improved as to enable them to sell as large a proportion of energy as is now sold by the low-tension systems, taking into account the loss of energy in the feeders.

The distribution of the energy after transformation is also a point requiring attention. The cables for this are at present large, and therefore necessarily expensive, and the only way in which improvement can be made in this direction is to get to such a system of house wiring in the way of safety and certainty as to enable a higher voltage to be used. Considerable improvements have already been made in the way of higher voltage incandescent lamps, but further improvement has also got to be made in this direction, which, together with a better system of wiring, would enable the capital expenditure in, and the annual loss on, distributing mains to be greatly reduced.

We now come to the question of what can be done at the generating station. There is here very great room for improvement. The apparatus forming the modern station is far too complicated in its many parts to be able to be run as cheaply as it should be, and this trouble is greatly added to by the large number of breakdowns due to that apparatus being in many cases of a most inferior quality, which in its turn is largely produced by the competitive tendering so much in vogue at present. Electrical engineers, and people who run electric light stations, have still got to learn that it is a matter of very small consequence to spend rather more capital on the plant in the station, and that the best plant that money can buy is none too good for the purpose.

What is most wanted in the way of improvement is to get such generating plant as will run with a better yearly economy, i. e., which will produce a Board of Trade unit under varying conditions of output at a lower expenditure for coal, oil, maintenance, and labor. There is a very serious discrepancy between the tests on full load of electric lighting plants and the results given by a good station for a year's working, and in this direction engineers will have to work in order to improve the position of the business of electrical supply.

I think that a very fair increase of economy may be obtained by superheating the steam running the engines to some 450° to 500° F., as a fairly lengthy experience on the Continent appears to have given very good results in this direction.

There is no doubt that the internal combustion engine will eventually be the cheapest and best motive power for use on a large scale in generating electrical energy, but, unfortunately, there is not to-day a single gas engine on the market which entirely complies with the everyday requirements of dynamo driving. Until this desirable end is achieved it will be necessary for engineers to work on improving the details, arrangements, and running of their steam plants, by whatever means lie in their power. I think that there is still a great deal which may be done in the way of economy in this direction.

The station managers must still further pursue the question which many of them have already taken up, of getting a better load factor for their stations. This is the most important thing to cheapen the supply, and a cheap supply will, in its turn, react to make the demand greater. It will, no doubt, then be possible to further reduce the price of the current, which will react again beneficially in the production of a demand for current for other purposes.

These things, coupled with the achievement of some of the improvements which I have indicated, will no doubt lead to a very widespread use of electrical energy, which it may be hoped will produce still greater improvements in the whole practice of generation and supply.—The Electrical Review.

THE MAGNETIC PROPERTIES OF LIQUID OXYGEN.

THE gist of the original references, by Prof. James Dewar, F.R.S., to the magnetic properties of liquid oxygen, in an address delivered by him before the Royal Institution of Great Britain, are well worthy of renewed attention at the present time in view of the current developments respecting this subject. After alluding to the generous aid which he had received, both from the Royal Institution and from others, in connection with his researches on the properties of liquid oxygen, and to the untiring assistance rendered him by his co-workers in the laboratory, Prof. Dewar said that on the occasion of the commemoration of the centenary of the birth of Michael Faraday he had demonstrated some of the properties of liquid oxygen. He hoped that evening to go several steps further, and to show liquid air, and to render visible some of its more extraordinary properties.

The apparatus employed consisted of the gas engine down stairs, which was driving two compressors. The chamber containing the oxygen to be liquefied was surrounded by two circuits, one traversed by ethylene, the other by nitrous oxide. Some liquid ethylene was admitted to the chamber belonging to its circuit and there evaporated. It was then returned to the compressor as gas and liquefied, and thence again into the compressor, as required. A similar cycle of operations was carried out with the nitrous oxide. There was a hundredweight of liquid ethylene prepared for the experiment. Ethylene was obtained from alcohol by the action of strong sulphuric acid. Its manufacture was exceedingly difficult, because dangerous, and as the efficiency of the process only amounted to 15 or 20 per cent., the preparation of a hundredweight of liquid was no light task. The cycle of operations, which for want of time was not fully explained, was the same as that commonly employed in refrigerating machinery working with ether or ammonia.

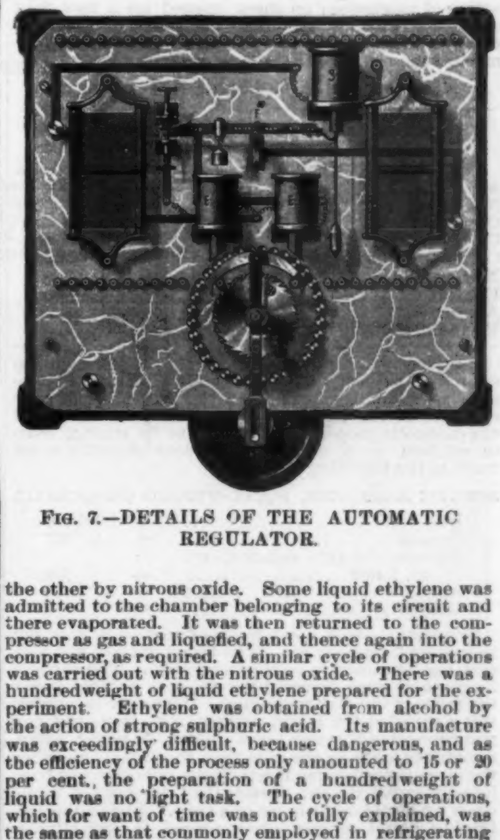


FIG. 7.—DETAILS OF THE AUTOMATIC REGULATOR.

The lecturer then exhibited to the audience a pint of liquid oxygen, which by its cloudy appearance showed that it contained traces of impurity. The oxygen was filtered, and then appeared as a clear transparent liquid with a slightly blue tinge. The density of oxygen gas at −182° C. is normal, and the latent heat of volatilization of the liquid is about 80 units. The capillarity of liquid oxygen at its boiling point was about one-sixth that of water. The temperature of liquid oxygen at atmospheric pressure, determined by the specific heat method, using platinum and silver, was −180° C.

Reference was then made to a remarkable experimental corroboration of the correctness for exceedingly low temperatures of Lord Kelvin and Prof. Tait's thermo-electric diagram. If the lines of copper and platinum were prolonged in the direction of negative temperature, they would intersect at −95° C. Similarly, the copper and palladium lines would cut one another at −170° C. Now, if this diagram were correct, the electromotive force of the thermo-electric junctions of these two pairs of metals should reverse at these points. A Cu—Pt junction connected to a reflecting galvanometer was then placed in oxygen vapor and cooled down. At −100° C. the spot of light stopped and reversed. A Cu—Pd junction was afterward placed in a tube containing liquid oxygen, and a similar reversal took place at about −170° C.

Liquid oxygen is a non-conductor of electricity; a spark taken from an induction coil, 1 millimeter long

in the liquid, requires a potential equal to a striking distance in air of 25 millimeters. It gave a flash now and then, when a bubble of the oxygen vapor in the boiling liquid came between the terminals. Thus liquid oxygen is a high insulator. When the spark is taken from a Wimshurst machine, the oxygen appears to allow the passage of a discharge to take place with much greater ease. The spectrum of the spark taken in the liquid is a continuous one, showing all the absorption bands.

As to its absorption spectrum, the lines, A and B, of the solar spectrum are due to oxygen, and they came out strongly when the liquid was interposed in the path of the rays from the electric lamp. Both the liquid and the highly compressed gas show a series of five absorption bands, situated respectively in the orange, yellow, green and blue of the spectrum.

Experiments prove that gaseous and liquid oxygen have substantially the same absorption spectra. This is a very noteworthy conclusion, considering that no compound of oxygen, so far as is known, gives the absorptions of oxygen. The persistency of the absorption through the stages of gaseous condensation toward complete liquidity implies a persistency of molecular constitution which we should hardly have expected. The absorptions of the class to which A and B belong must be those most easily assumed by the diatomic molecules (O_2) of ordinary oxygen; whereas the diffuse bands above referred to, seeing they have intensities proportioned to the square of the density of the gas, must depend on a change produced by compression. This may be brought about in two ways, either by the formation of more complex molecules or by the constraint to which the molecules are subjected during their encounters with one another.

When the evaporation of liquid oxygen is accelerated by the action of a high expansion pump and an open test tube is inserted into it, the tube begins to fill up with liquid atmospheric air, produced at the ordinary barometric pressure.

Dr. Jansen had recently been making prolonged and careful experiments on Mont Blanc, and he found that these oxygen lines disappeared more and more from the solar spectrum as he reached higher altitudes. The lines at all elevations come out more strongly when the sun is low, because the rays then have to traverse greater thicknesses of the earth's atmosphere.

Michael Faraday's experiments made in 1849 on the action of magnetism on gases opened up a new field of investigation. The following table, in which + means "magnetic," and — means "negative," summarizes the results of Faraday's experiments:

MAGNETIC RELATIONS OF GASES (FARADAY).

	In Air.	In Carbonic Acid.	In Hydrogen.	In Coal Gas.
Air..........	0	+	+weak	+
Nitrogen..........	—	—	—strong	—
Oxygen..........	+	+	+strong	+strong
Carbonic acid..........	....	0	—	—weak
Carbonic oxide..........	—	—	—	—weak
Nitric oxide..........	—weak	+	+	......
Ethylene..........	—	—	—	—weak
Ammonia..........	—	—	—	.....
Hydrochloric acid..	—	—	—weak	.....

Becquerel was before Faraday in experimenting upon this subject. Becquerel allowed charcoal to absorb gases, and then examined the properties of such charcoal in the magnetic field. He thus discovered the magnetic properties of oxygen to be strong, even in relation to a solution of ferrous chloride, as set forth in the following table:

SPECIFIC MAGNETISM, EQUAL WEIGHTS (BECQUEREL).

Iron..........	+	1,000,000
Oxygen..........	+	377
Ferrous chloride solution, sp. gr. 1·4334..........	+	140
Air..........	+	88
Water..........	—	3

The lecturer took a cup made of rock salt and put in it some liquid oxygen. The liquid did not wet rock salt, but remained in a spheroidal state. The cup and its contents were placed between and a little below the poles of the electro-magnet. Whenever the circuit was completed the liquid oxygen rose from the cup and connected the two poles. Then it boiled away, sometimes more on one pole than the other, and when the circuit was broken it fell off the pole in drops back into the cup. He also showed that the magnet would draw up liquid oxygen out of a tube. A test tube containing liquid oxygen when placed in the Hughes balance produced no disturbing effect. The magnetic moment of liquid oxygen is about 1,000 when the magnetic moment of iron is taken as 1,000,000. On cooling, some bodies increased in magnetic power. Cotton wool, moistened with liquid oxygen, was strongly attracted by the magnet and the liquid oxygen was actually sucked out of it on to the poles. A crystal of ferrous sulphate, similarly cooled, stuck to one of the poles.

The lecturer remarked that fluorine is so much like oxygen in its properties that he ventured to predict that it will turn out to be a magnetic gas.

Nitrogen liquefies at a lower temperature than oxygen, and one would expect the oxygen to come down before the nitrogen when air is liquefied, as stated in some text books, but unfortunately it is not true. They liquefy together. In evaporating, however, the nitrogen boils off before the oxygen. He poured two or three ounces of liquid air into a test tube, and a smouldering splinter of wood dipped into the mouth of the tube was not reignited: the bulk of the nitrogen was nearly five minutes in boiling off, after which a smouldering splinter dipped into the mouth of the test tube burst into flame.

Between the poles of the magnet all the liquefied air went to the poles; there was no separation of the oxygen and nitrogen. Liquid air has the same high insulating power as liquid oxygen. The phenomena presented by liquefied gases present an unlimited field for investigation. At —200° C. the molecules of oxygen had only one-half of their ordinary velocity and had lost three-fourths of their energy. At such low temperatures they seemed to be drawing near what might be called the "death of matter," so far as chemical action was concerned; liquid oxygen, for instance, had no action upon a piece of phosphorus and potassium or sodium dropped into it; and once he thought, and publicly stated, that at such temperatures all chemical action ceased. That statement required some qualification, because a photographic plate placed in liquid oxygen could be acted upon by radiant energy, and at a temperature of —200° C. was still sensitive to light.

Professor McKendrick had tried the effect of these low temperatures upon the spores of microbic organisms, by submitting in sealed glass tubes blood, milk, flesh, and such like substances for one hour to a temperature of 182° C., and subsequently keeping them at blood heat for some days. The tubes on being opened were all putrid. Seeds also withstood the action of a similar amount of cold.

SUBMARINE CABLE GRAPNELS.

WE illustrate two new forms of grapnels which are just being introduced by Messrs. Johnson & Phillips,

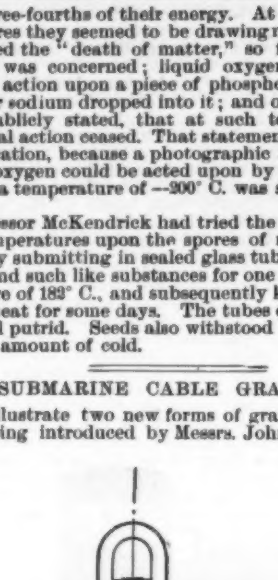


FIG. 1.

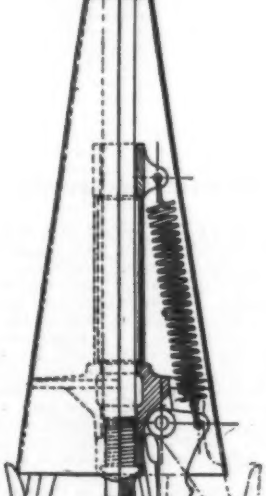


FIG. 2.

of Charlton, who, it is well known, make a specialty of all descriptions of apparatus for the laying and repairing of submarine cables.

The grapnels are the invention of Mr. Claude Johnson.

Fig. 1 is a sectional elevation of his patent collapsible grapnel for the recovery of cables lying on rocky bottoms. Fig. 2 shows its outward appearance.

In this grapnel the prongs are pivoted to the shank, and under normal conditions they project beyond the edges of the conical shield which forms the body of the grapnel. Should any of the prongs come in contact with rock, they recede within the shield sufficiently far to enable the grapnel to clear the obstruction. The pivots of the prongs are so arranged that a very slight movement of the points is sufficient to bring them completely under the protection of the shield, and if a prong is forced back after the cable has been hooked, it still retains the cable perfectly; as the prongs are arranged to collapse inward, the instrument is enabled to pass channels in which it would otherwise be held fast.

Fig. 3 is an illustration of patent grapnel for the recovery of cables in mud bottoms.

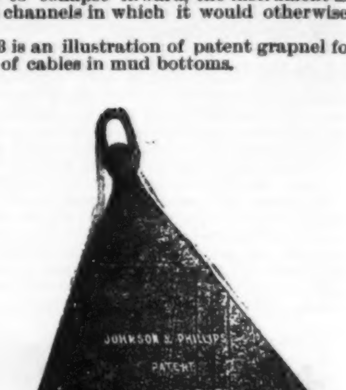


FIG. 3.

This grapnel has two steel prongs, which are comparatively thin, but deep in section, so as to offer little resistance to their penetration into the mud.

The prongs are connected to one end of a broad flat plate, which constitutes the shank, the plane of which is at right angles to the plane of the prong.

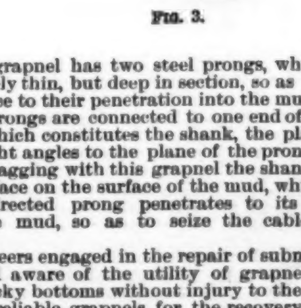
On dragging with this grapnel the shank slides with its flat face on the surface of the mud, while the downward directed prong penetrates to its full length into the mud, so as to seize the cable embedded therein.

Engineers engaged in the repair of submarine cables are well aware of the utility of grapnels which will drag rocky bottoms without injury to the prongs, and also of reliable grapnels for the recovery of cables of muddy bottoms.—The Electrical Review.

THE OHNESORGE TELEPHONE.

HERR W. OHNESORGE, of Frankfort, Germany, has recently introduced a telephone presenting some novel features. Telephones with wire cores have hitherto been distinguished for their precise working, but have had the disadvantage of rendering sounds very faintly. Herr Ohnesorge discovered that if the spiral iron wire forming the core project from the coil by a certain amount, the strength of the sound is increased in a manner quite out of proportion to the difference in position. The discovery is utilized in the instrument, of which the accompanying illustration, from the London Electrician, shows the details.

The spiral spring forming the core is of steel or iron wire, thoroughly hardened, and with the turns just so far apart as not to touch. This spring is of such a size as to permit free movement inside the tube of the bobbin without touching the sides, and is made



THE OHNESORGE TELEPHONE.

of wire one millimeter in diameter. The one end is fastened to a sounding board in front of the telephone, while the back end, projecting behind the coil by about the length of the latter, is fastened to an adjustment screw, which regulates the tension on the spring.

Such an instrument speaks loudly and clearly, and renders song or musical tones perfectly. Steel wire speaks less loudly than hardened iron wire, and magnetizing the spring also increases the volume of sound; the latter course is necessary if the instrument is to be used as a transmitter. It is found that if in the center of the spring, or at several equidistant points, the adjacent turns are more widely separated than the average, the sound is also in-

creased and the spring appears to oscillate sideways as well as longitudinally; and the same effect is produced by putting the spring skewed into the coil. The telephone is very simple, cheap and easily regulated.

THE CHILEAN CRUISER CAPITAN PRAT.

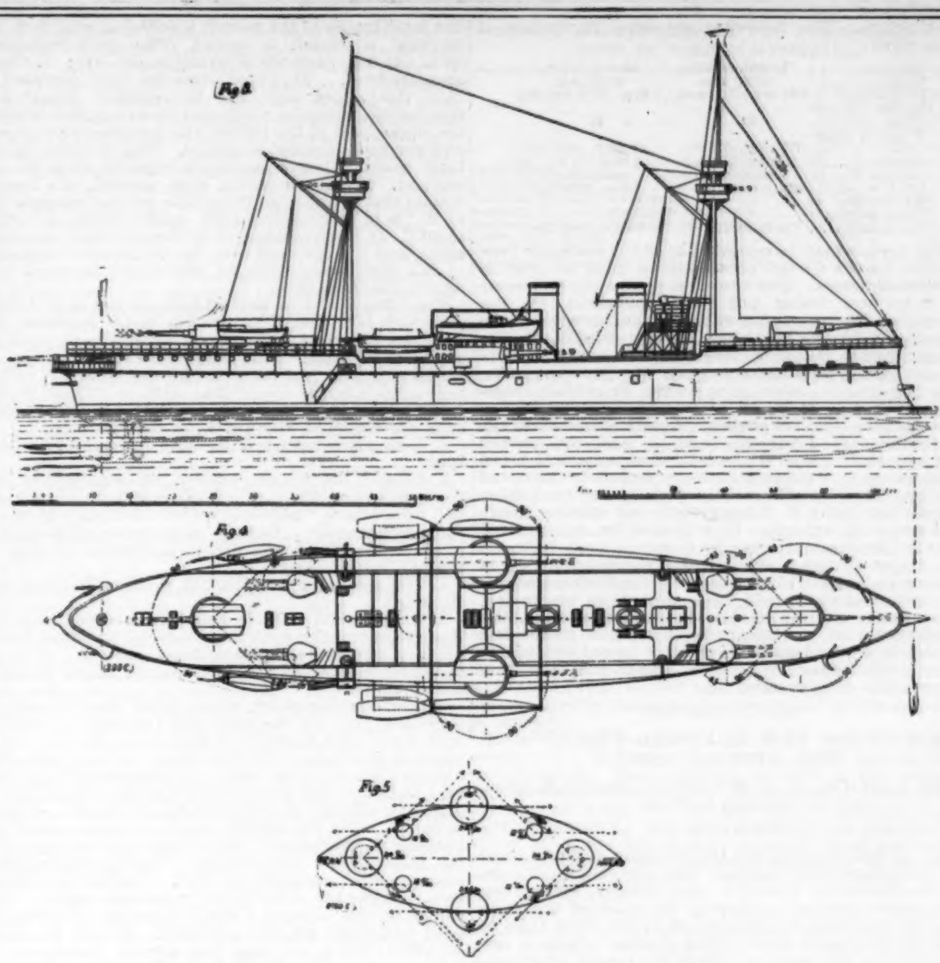
BEFORE the Chilean government decided on the construction of this armored cruiser, it invited various European constructors to submit competitive designs to an international commission, the English member of which was Sir E. J. Reed. After a careful investigation the commission intrusted the work to the Forges et Chantiers de la Mediterranee. The plans for the ship were prepared by M. Lagane, the engineer-in-chief of the company, at La Seyne. The Capitan Prat is 100 meters (328 ft.) long and 18·50 meters (61 ft. 2 in.) wide across the amidship batteries; her draught of water is 6·65 meters (21 ft. 10 in.), and her tonnage, 6,828. Of this total, the weight of the hull as a complete structure accounts for 36 per cent.; the armor plating, 37·3 per cent.; boilers and machinery of all kinds, 16 per cent.; artillery and ammunition, 9 per cent., and the normal coal provision 5·4 per cent., leaving about 443 tons for stores, the smaller armament, crew, etc.

The Capitan Prat is built with a double hull, and is divided by 14 transverse bulkheads, besides a number of smaller watertight compartments for the magazines of various kinds. She is protected for the greater part of her length by a belt of steel plates 150 millimeters (5·90 in.) at the forward end, 300 millimeters (11·81 in.) amidships, and 125 millimeters (4·91 in.) aft; the total height of this belt is 2·10 meters (6 ft. 10·6 in.), the uniform height above the water line being 0·70 meter (27·56 in.).

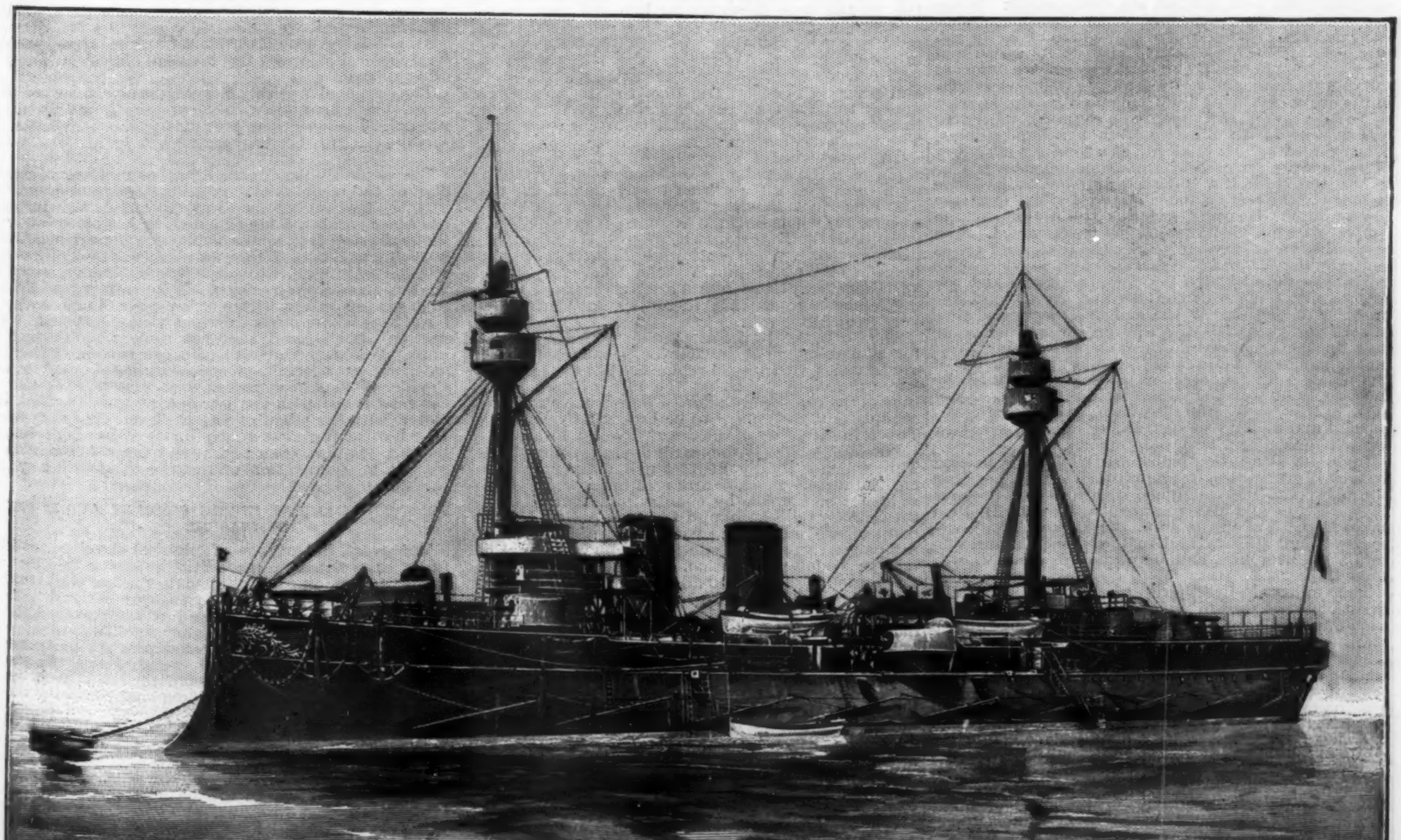
At the level of the top of the armor belt, which is backed with teak, is a teak deck on which rests the plating of the armor deck, 2·60 in., made up of two plates 1·97 in. and 0·63 in. respectively. Above this is a cellular space extending over the length and breadth of the ship. The central part of the vessel forms an armored citadel, extends across the whole width, and for a length of about 100 ft.; the thickness of the armor at the ends is 3·78 in., made up of two plates of 3·15 in. and 0·63 in. This inclosure is divided into two decks, the lower one being a part of the cellular space above referred to, and containing a reserve of about 300 tons of coal, which also serves as an additional protection. Above this is a battery deck, armed with six Hotchkiss 2·24 in. guns and two Canet torpedo tubes. The rest of the 1,873 tons of armor is divided between the four turrets of the 9·45 in. guns, the four of the 4·72 in., the protecting tubes of the ammunition hoist, and the commander's shelter. The armament of the Capitan Prat is as follows:

Four guns of 24 centimeters (9·45 in.) of 36 calibers, Canet system; these are placed in barbette, arranged as shown on the annexed diagram, Fig. 4 (type Marceau).
Eight quick-firing guns of 12 centimeters (4·72 in), of 45 calibers, Canet system; these are mounted in intermediate positions in closed turrets.
Six Hotchkiss guns, 2·24 in., in the battery.
Four Hotchkiss guns, 2·24 in., mounted on platforms directly over the 24 centimeter barbettes.
Four machine guns, 1·85 in., on the flying decks.
Four Hotchkiss guns, 1·46 in., in the lower tops.
Two Hotchkiss guns, 1·46 in., on the captain's bridge.
Five Gatlings, 0·43 in., in the upper tops.
Four Canet torpedo tubes, 17·72 in. in diameter; of these, two are placed in the central battery, the third aft, and the fourth forward.

From the diagram, Fig. 5, it will be seen that one-half the horizon, between 45 degrees forward and 45 degrees aft, on each side of the ship is commanded by three guns of 24 centimeters and four guns of 12 centimeters, while the other half of the circle is swept by two guns of 24 centimeters and by two of 12



THE CHILEAN CRUISER CAPITAN PRAT.



THE CHILEAN CRUISER CAPITAN PRAT.

centimeters. The following are some particulars of these guns:

Caliber	24 cent. (9·45 in.)	12 cent. (4·7 in.)
Weight	23·300 tons.	2·700 tons.
Length	8·64 m (28 ft. 1·20 in.)	5·40 m. (17 ft. 8·60 in.)
Length in calibers	36	45
Weight of projectile	170 kilog. (374 lb.)	21 kilog. (46·2 lb.)
Weight of charge	90 kilog. (198 lb.) (chocolate)	5 kilog. (11 lb.) (smokeless)
Initial velocity	680 m. (2,230 ft.)	700 m. (2,296 ft.)
Thickness of plate perforated at muzzle	0·62 m. (24·41 in.)	0·225 m. (8·85 in.)

The turrets may be regarded as of the ordinary type used in France for the protection of guns of from 19 to 24 centimeters. The system is practically the same as that now being put into execution by the Forges et Chantiers for working the turrets on the warship Pothuan; for the coastguard ship Skyold, intended for the Danish government, and for the turrets to contain the 28 centimeter guns for the Carlos V., now in course of construction by the Spanish government at Cadiz. It is an interesting and significant fact that the Spanish government has abandoned the hydraulic-worked turrets, such as were constructed and supplied by the Whitworth Company, and fitted on three new cruisers, and have definitely accepted the system of working by electricity for some other ships—the Carlos V. among them—as offering many and great advantages. It will also be remembered that the hydraulic turrets in question were built on the Canet system. The Forges et Chantiers de la Mediterranee have also in progress the Entrecasteaux, the turrets of which will be operated by electricity. From this it will be seen that, in France at least, the substitution of electrical for hydraulic power has ceased to be problematical, and has passed out of the experimental phase into that of actual adoption on a large scale.—Engineering.

RECRUITING AND PHYSICAL TRAINING IN THE BRITISH ARMY.*

By Lieut.-Col. A. A. WOODHULL, Deputy Surgeon-General, U. S. A.

RECRUITING.

As is well known, the British army is maintained by voluntary enlistments. The physical conditions for acceptance as a soldier vary greatly within certain general limits for different branches of the service, and they are also changed by orders from time to time for the same corps. The medical officer is responsible for the measurement of the height, chest and weight of the recruits, and for their age being in accordance with the army schedule.

At present the requirements for the mass of the army are: Minimum height, 5 feet 4 inches; weight, 115 pounds; age, between 18 and 26 years; chest measurement, between 64 and 66 inches of height, 33 inches; 66-70 inches of height, 34 inches; above 70 inches, 35 inches. These points will be taken up presently.

While not directly bearing upon the duties of medical officers as such, the question of maintaining a large army without compulsory service is of interest, and some of the formalities wherein the British methods differ from our own are worth study. When a candidate offers reference as to character, the recruiting officer uses a form of polite inquiry to the referee, asking five questions: Capacity in which and for what time known; when last seen; character as to sobriety, honesty and respectability; previous service in the army, militia or navy; married or single, with space for answers, the paper to be returned. The man is then served with a notice by a non-commissioned officer requiring him to attend at a specified hour and place "for the purpose of appearing before a justice to be attested for Her Majesty's army." This notice explains to the recruit under eleven distinct headings the conditions of service, so far as the division of the twelve years for which he engages is concerned. Men may enlist for twenty-one years or long service; or, as generally done, for twelve years or short service. The twelve years are divided between the colors and the reserve, into 3 or 7 with the one and 9 or 5 with the other, as they elect. At the end of either period they may re-engage. He is also told on the notice that he may be discharged within three months of enlistment on the payment of not more than £10. The back of the notice contains eighteen questions to which he must reply on enlistment, and false answers to any of eight of these as to apprenticeship, marriage, imprisonment and military service, render him liable to two years' imprisonment with hard labor.

Upon his attestation (enlistment), which is effected by a civil magistrate, not a military officer, he signs the answers to these eighteen questions and declares they are true, and his signature is witnessed. He then takes the oath of allegiance to the crown, and of obedience to Her Majesty and to the "generals and officers" set over him, and his signature is again witnessed.

Then follows the certificate of the justice that the questions were read to the recruit, who "understands each question" and that he has signed the declaration and the oath in his presence, giving place and date. The questions point, among other matters, to the particular parish where he would become entitled to support if necessary, and one, "Are you willing to be vaccinated or revaccinated?" is at once unusually precise and recognizes a popular prejudice.

A negative answer stops the enlistment. I do not suppose that at the large recruiting offices, as in the great cities, the reference as to character or the formal notice of attendance is specifically carried out, but that the applicants are taken up for examination as expeditiously as possible.

Also, of course, the physical examination and the inspection by the recruiting officer are completed before the man is brought before the magistrate for the questioning and the formal oath which completes the enlistment.

The medical officer is charged with determining that the intelligence of the recruit is sufficient and that his physical condition is sound. The chief variations from our own methods of examination are: 1. Chest measurement. To obtain this the tape is placed so that the upper edge lies immediately below and touches the shoulder blade and the lower edge touches the upper part of the nipple, the arms hanging loosely and the surface not compressed. This position of the tape gives a larger apparent capacity than by our method. When the tape is thus applied, the recruit counts slowly from 1 to 10 and the circumference noted at 10 "is to be considered the correct chest measurement." It is also spoken of as the minimum measurement, and it is directed that the maximum expansion of the chest should also be taken and recorded as a denominator, as 33-35.

Fractions less than half an inch are not to be noted. Although both sets of figures are to be recorded, the so-called minimum is that upon which the recruit's acceptance depends. This is not reached by forcible expansion and, as just pointed out, the situation of the tape gives a larger record than with us. Chest mobility therefore plays no necessary part. It results that men are accepted who are below our standard.

2. Vision is determined by dots instead of by test-types.

3. Should the recruit present no satisfactory evidence as to age, the medical officer will decide his age and note him as "physically equivalent to" so many years and months. But the man's own statement is taken as his official age, and he is entered as such on the public documents.

4. The minimum weight, 115 pounds, is below our standard.

5. There is no minute search for and record of distinguishing marks, such as we now use to expose fraudulent enlistments and to identify deserters. A record of the more conspicuous marks only is made, as in our older fashion.

The attestation paper, which is the most important document both for the army and the man, connected with the soldier, consists of four large papers and is made in duplicate. The first page is filled with the eighteen questions and answers, the recruit's declaration and oath, and the certificate of the magistrate or attesting officer. It is the enlistment paper, properly so called. On the second page are noted under the heading "Description:" Age physically equivalent to (so many years and months), height, weight, chest measurement, complexion, hair, religious denomination. Marks are noted in an adjoining space. This would be the basis of a descriptive list, although no such additional paper is prepared. Should the medical officer think the man has served before, he attaches a slip of paper to that effect, unless the man acknowledges it.

Succeeding is a certificate of medical examination, to the effect that the recruit presents none of the disqualifications enumerated in the regulations, that his vision with either eye is as required, that his heart and lungs are healthy, that he has free use of his joints and limbs, and that he declares that he is not subject to fits. Then follows the simple statement: "I consider him fit (or unfit) for the army." "Fit" and "unfit" are the simple and universally employed terms by which the qualification of the soldier is expressed at almost every point of his career. The recruiting officer then follows with a certificate that the recruit was inspected by him and that he considers him fit (or unfit) for the service in the (regiment or corps), and that due care has been exercised in the enlistment. Following this is the approving field officer's certificate, that the attestation is correct and properly filled up and that the required forms appear to have been complied with, and "I accordingly approve and appoint him to the (regiment)." The man's destination is fixed at once.

The enlistment of men who do not agree in physique with the standard requirements is provided for on a form that gives a brief description of the man. The officer commanding forwards this, with his reasons for recommending the application to the adjutant general, at the Horse Guards, where it is authorized or disapproved. When authorized, that paper is attached to the attestation, and the deficiencies or other variations from the standard are thus condoned. It is my understanding that these "special" enlistments very frequently occur.

The third page of the attestation paper is arranged for a statement of services as to corps, changes in grade, dates with special reference to service not allowed to reckon for fixing the rate of pension, and that in the reserve not allowed to reckon toward good conduct pay, each entry to be certified by an officer. This is in extension of the descriptive list idea.

The fourth page is the man's military history sheet. This, which is totally distinct and different from his medical history sheet, is arranged to show his service at home and abroad, by country and time. It notes the military school through which he passed, if a boy; certificates of education; passed classes of instruction; campaigns; wounded; effects of wounds; special gallantry; medals; decoration, etc.; deferred pay, issued and refunded; name and address of next of kin; particulars as to marriage, giving the woman's names, whether spinster or widow, date and place, names of officiating minister or registrar and two witnesses, and date when placed on the marriage roll; particulars as to children, giving Christian name, date and place of birth, date and place of baptism and name of officiating minister. Each of these entries is certified by the initials of an officer. The entry of "next of kin," which appears on the descriptive list of our own marine corps as "name and address of nearest relative or friend," is a point that might be adopted on our descriptive lists, in one form or the other, with advantage to both the government and the soldier.

All the original attestations are not sent to a central office, as might be anticipated, but are distributed among twenty groups, each of which has a distinct place of deposit, but none is sent to the headquarters of the army, the Horse Guards. Consequently there is no common place for comparison or reference. The duplicates go to the man's commanding officers and accompany them at home and abroad. All incidents affecting the man's enlistment, appointment or deprivation as to rank or pay, conviction by civil authority or court martial, and his whole service at home and abroad, are to be entered thereon as they occur. The duplicate attestations are sent at the beginning of each year to the custodians of the originals for checking, so as to preserve them in accord.

The attestation paper is practically an original enlistment paper and descriptive list combined, with the account of pay and clothing omitted. The duplicate replaces our descriptive book, and, in the absence of muster rolls prepared at regular intervals and containing the data that we enter upon them, the originals at these diverse headquarters serve that purpose. Each man's record is thus separate and distinct, instead of being crowded between those of others and reiterated from six to twelve times a year; or as sometimes is the case, passing to the rolls of different companies by transfer and to different parts of the same roll by promotion or reduction. But while our own system involves much clerical labor, I failed to learn how the accuracy of this multiplicity of separate papers and their security are maintained during really active campaigns of considerable duration. There is no second physical examination, at the depot or elsewhere. As soon as a soldier is assigned to a corps, he is given a regimental number which is never changed. Nor in the case of death or discharge is a number once assigned bestowed upon another man. In all documents pertaining to the soldier the number invariably precedes the name. Should a man going into action wear his number on a metal tag suspended about his neck as a scapular, he could be determined with the aid of his regimental marks without difficulty. This, I believe, the Germans do.

The numbers are given in sequence, authority to commence a new series being obtained as 9999 is approached. The Royal Artillery and the Royal Engineers are extended ten and three times as many respectively. An assumed name under which a soldier may enlist cannot be erased from his papers. He may, if he desire, certain formalities being accomplished, follow his assumed name by his true name as an alias.

The medical history sheet of a recruit is prepared by the approving medical officer at the time of examination. Only such physical marks are noted on it as have a professional interest. This goes forward with the attestation of the commanding officer of the man's corps, by whom, when the man's regimental number is inserted, it is given to the medical officer in charge of the station hospital. The details of this paper and its disposition have already been described. At every place where recruits are examined recruits' registers are kept, which may not be removed from the place of examination. Registers of recruits, a different book, are kept by officers commanding regimental, auxiliary, artillery and recruiting districts. Recruits' registers require the particulars to be fully stated under each of the following heads, whether the recruit is found fit or unfit: Date, regiment or corps, name, apparent age, years, height, inches, weight, pounds, chest measurement over the upper part of the nipple, inches, marks of vaccination or smallpox, place of birth, subdivided into parish or county or country if abroad, England, Ireland, Scotland, British colonies, foreign countries, trade or occupation, state of education, subdivided into well educated, can write, can read only, cannot read, primary inspection, secondary inspection, transfers from the militia, each of the last three being divided into fit and unfit, whether previously served, remarks as to cause of rejection, and any distinctive marks, with the medical officer's signature.

An annual return of recruits is furnished to the principal medical officer by the medical officers in charge of recruiting.

The principal medical officer prepares a summary of these, which he sends with the original to the director general. I believe these are numerical, not nominal.

PHYSICAL EXAMINATION OF OFFICERS.

The responsibility for the fitness or unfitness of candidates for commissions in the army rests entirely with the medical boards. But they are not to reject eligible candidates for shortness of stature or other slight physical defect. If a candidate can read Snellen's D=6 at 6 meters or 20 feet, and D=0·6 at any distance selected by himself, with each eye separately, he will be considered fit as to vision. If he cannot read with each eye separately without glasses D=36 at 6 meters, i. e., if he have not 1/6 normal vision, although he may be able to read D=0·6 at some distance, he is unfit. If he can read with each eye separately D=18 at 6 meters without glasses, but not beyond, and the defect may be corrected with glasses so that he can read D=0·6 with one eye and at least D=12 at 6 meters with the other, and at the same time can read D=0·8 without glasses at any distance he may select, he is fit. Squint, color blindness, or morbid condition subject to aggravation or recurrence, of either eye, rejects.

PHYSICAL TRAINING IN THE COMPANY AND IN THE GYMNASIUM.

The great importance of physical development is fully appreciated in the British army. The term "physical training" is limited in the technical sense to the exercise in the company that we still call "setting up," and its motive is said to be to expand the soldier's chest and develop his muscles. This is divided into nine exercises, and begins with swinging the arms in circles. The next is to bend and stretch the body, then to bend and stretch the arms, then the lunge and engage, next bending and stretching the knees. The sixth exercise is a combination of the second and fourth. The seventh is one of four practices for the development of the shoulder by striking out. The eighth is a union of the fourth and seventh, and the ninth is a combination of the whole. These may be practiced singly or in squads, or by company; and they are adapted to music, whose use is encouraged. For a part of them it is recommended that airs with choruses be chosen and the men are allowed to sing the chorus, and they are encouraged to sing through the whole of the eighth exercise. It is officially set forth that the exercises are not to be carried to the point of fatigue, and that they should be varied and be made very short, to avoid fatigue and lack of interest. This is to be practiced constantly, at all seasons of the year and under all circumstances, up to the age of 35 years.

I give no more minute description, because the whole

* From "Observations upon the Medical Department of the British Army," by the author, published in the Proceedings of the Association of Military Surgeons. Vol. IV. 1894. Journal of the Military Service Institution.

matter is detailed in the infantry drill of 1889, an easily accessible book. In my judgment these exercises are better adapted to the purpose of symmetrical development, are simpler and are more attractive to the soldier than our later drill; and since they are good, I see no reason that their foreign origin should bar their adoption. The regulation "attention," which is the point of departure, and to maintain which is one of the objects in view, is practically identical in both armies, except that with the English the feet make an angle of 45° instead 60° as with us.

Notwithstanding inferior material, there is no question that the British soldier looks better on duty, and as a soldier is more active than our own. To the systematic gymnastic instruction now in force, which is an amplification and an extension of the physical training proper, they are much indebted for this superiority.

The gymnastic instruction is required for all young officers of the line (in our sense of the word) and for the men. There are two principal gymnasia in Great Britain: at Aldershot, and at the Curragh, near Dublin. The parent one is at Aldershot. These are employed not only for local use, but for training non-commissioned officers as instructors in gymnastics. A gymnasium is supposed to be in operation at every station.

The gymnastic training of the cavalry recruit is carried on simultaneously with his foot drills, and he begins no riding until this course, which lasts two months and must not be interrupted, is finished. It occupies one hour a day.

The infantry recruit begins directly after completing his physical training with the company, which usually is one month after joining. The course is an uninterrupted one of six weeks, an hour and a half daily. Recruit officers are to undergo the same course and at the same time, unless found efficient and properly excused. Weak and awkward men are kept under this training for three months, and if below the standard of efficiency at that time they are then to be reported to the adjutant general.

Besides training the recruits, gymnasia are maintained to harden and strengthen the trained soldier, so that at least he may cover 1,000 yards rapidly and then be in condition for efficient bayonet work. To do this with as little interference as possible with the ordinary military duties, men, according to the size of the gymnasium, but not exceeding one-sixth of the garrison, are to be selected and strictly examined medically. These are then put into squads for attendance one hour on alternate days, not exceeding three months. Guards are not to be interfered with. Men under thirty must attend, but with men over thirty the course is optional, subject to the medical officer's approval. Voluntary classes for advanced work may be formed, but no man may join them until after one month's instruction.

Medical officers serving with regiments that have undergone gymnastic training "will specially report on the effects of such training on the muscular development and health of the men on their leaving the station, and as to the general influence of gymnastics in producing a vigorous constitution." They are to visit frequently the gymnasium and witness the measurements of the recruits on entering and completing the course. The principal medical officer is to refer to the subject in his annual sanitary reports, giving the substance of the information supplied by the medical officers, and his own remarks on the utility of the gymnasium.

The gymnasium building at Aldershot is not perfectly adapted, on account of size and some minor matters, for its purpose, but the work done in it is admirable. The apparatus is of the simplest description, and the floor may be cleared without delay. Parallel bars, light Indian clubs, light dumb bells, a vaulting horse, inclined ladders and the like are all. Using these, but more particularly using them with care, very capital results are obtained. The young men develop in chest girth and muscle, the weak gain strength, the awkward agility and the timid confidence. One side of the room is arranged with very trifling foothold for perpendicular escalading, up which men scale successfully, and at one end of the room is a shelf about eight feet from the floor, which men are taught to reach without other help than they can give one another. The ease with which every exercise is performed is delightful to witness. The impression received in watching these exercises was that men with no special physical gifts were brought up rapidly and without distress into admirable condition, and that their military efficiency was greatly increased thereby. It was evident that the men themselves appreciated and enjoyed the work.

The system used is a modification of the Ling method, developed by Sergeant-Major Noakes, chief instructor of gymnastics in the army, known as "free gymnastics with light dumbbell drill." It is practiced on the floor of all the gymnasia, and the company "physical training" closely follows it. The testimony of good observers is that this method improves the carriage and condition better than the older way. Besides the gymnasium training of the recruits and the older men, there are semi-annual classes at Aldershot and the Curragh of non-commissioned officers to be fitted as instructors of gymnastics. These men, sent from various regiments on their own application, are given a more thorough course and develop into skilled gymnasts; but their work, like that of all the rest, is done gradually and without strain. I saw at Aldershot some beautiful examples, in the open air, of running in fours over obstacles, such as hedges, ditches, along the string pieces of bridges whose floors had been torn up, and scaling high wooden and brick walls. These central schools sending out classes of instructors uniformly trained, enable every gymnasium to be conducted in substantially the same manner. And such work as I observed at Dublin seemed animated by the same interest and the same energy. Before going abroad I saw, in 1891, at the recruiting depot, Davids Island, elementary gymnastics taught under unfavorable conditions in a method so similar to that observed in England that I am confident that the instructor was trained at Aldershot. So simple and efficient a method deserves introduction wherever there is a garrison and a shelter can be found or made.

The whole gymnasium system is directly regulated by an inspector of gymnasia, and each gymnasium is under the command of a superintendent. An annual class of officers for instruction to fill these places is held at Aldershot, which is an additional guarantee of uniformity. Before the men are allowed to commence the course, a strict medical examination is made of each, and his height, chest, forearm and upper arm are measured in the presence of the superintendent. These measurements are repeated at the end of the course, or when he returns to duty, and the particulars, with the age and weight of the man, are entered in the prescribed book kept at the gymnasium. I think the facts justify the official declaration of the character of the exercises, that they "are so arranged that, while the most advanced course is sufficient to test the powers of the strongest, the preliminary course can be performed without injury to the weakest frame."

Besides the general gymnastics, the cavalry recruits are given a course of instruction in fencing one hour a day for thirty days, and then a course of single-stick drill one hour a day for forty days. Before being allowed to compete for swordsmanship prizes in the riding school, every trained soldier must go through an annual course of single stick one hour a day for six days. Every encouragement is given to keep up this practice voluntarily, and the instructors are enjoined to pay special attention to the men attending during voluntary hours.

Young cavalry officers on joining are required to take the same course as recruits in these matters, and the same is required of young infantry officers at stations where there are gymnasia. I have seen them at Aldershot under training on the same floor and at the same time as recruits.

A regulation requires the art of swimming to be taught as a military duty at all stations where there are facilities, and at bathing parades the skilled swimmers are distributed as instructors.

Athletic games, comprehended under the general term of "sports," are systematically encouraged in the army. The public competitions are made gala days for the regiments concerned, and military equipment and supplies are provided for the occasion. The sports are looked forward to with interest and participated in with zeal, and the officers and their families and the men of other regiments are present in large numbers as applauding spectators. This wise interest has a most stimulating and healthy effect. This physical development of the soldier, in whom the fighting instinct is naturally strong, gives to the British army much of the formidableness it possesses, notwithstanding certain deficiencies in the original material and other incidental conditions of the service.

PRACTICAL NOTES ON CONCRETE.*

By SPENCER B. NEWBERRY.

THE making of good cement concrete is a comparatively simple matter, and yet, like most simple operations in engineering, there is a right way and a wrong way of doing it. Probably nine-tenths of the concrete work done falls far short of the strength it might develop, owing to incorrect proportions, use of too much water, and imperfect mixing. All authorities are agreed upon the importance of thorough mixing and use of the minimum quantity of water in all classes of concrete work. The matter of correct proportions of cement, sand, broken stone, etc., is one which requires some thought and calculation, and by proportioning these ingredients correctly an immense saving in cost and increase in strength can easily be secured.

The chief object in compounding concrete is to produce a compact mass, as free as possible from pores or open spaces; in short, to imitate solid rock as closely as possible. Cement is the "essence of rock" in portable form, and by its judicious use granular or fragmentary materials may be bound together into solid blocks of any desired size and shape, which in strength and wearing qualities are at least equal to the best stone that comes from the quarries. Cement is, however, very costly in comparison with the other ingredients of concrete, and must not be used wastefully. A little cement, judiciously used, is better than a large quantity thrown in recklessly, as a little study of the principles involved will plainly show.

To produce a compact mass from fragmentary materials, the voids must be filled. Imagine a box holding one cubic foot. If this were filled with spheres of uniform size, the voids or open spaces would be one-third the total volume, or 33⅓ per cent.; with spheres of various sizes, as, for example, from large marbles down to small shot, the voids would be much less, and it would theoretically be possible, by the use of spheres of graded sizes, from the largest down to dust of infinite fineness, to fill the box completely, so that there should be no voids whatever. In practice it is well known that the use of materials of varying fineness gives the best concrete, since the voids are much less than in materials composed of pieces of uniform size. Hence the common practice of making concrete with cement, sand and broken stone, instead of with cement and sand or cement and stone only. The sand fills the voids, and if the proportions are correct, a practically solid mass results. As an example of this, the writer found that briquettes of cement with three parts sand and four parts gravel showed higher tensile strength at 28 days than those made with three parts sand only.

The following table gives the relative weights of a given volume of different materials, and also the percentage of voids, as determined by the writer. The materials were shaken down in a liter measure by giving one hundred taps on the table, and weighed. In the case of the broken stone a larger measure was used. The voids were calculated from the specific gravity.

Comparison of the three different grades of Sandusky Bay sand shows how greatly the percentage of voids varies with the proportion of fine and coarse grains present. The first is the natural sand, not screened, as pumped up by the sand sucker from the bottom of the bay, and contains a large amount of fine gravel. The second is the same, passed through a 20-mesh screen to remove the coarse particles. It will be seen that this operation increases the proportion of voids from 32 to 38 per cent. The third is the same sand passing a 20-mesh and retained on a 30-mesh screen, thus brought to the fineness of the "standard sand" used in cement testing. This shows 40·7 per cent. of voids, owing to the uniform size of the grains. The same relation is seen in the two grades of gravel given in the table, that containing finer grains showing much the lower percentage of voids. These figures illustrate the imprudence of screening any of the materials used in making concrete. The presence of clay in sand is, however, objectionable, not because of its fine state of subdivision, but because the clay coats the sand particles and prevents the adhesion of the cement. Such sand might be improved by washing, but probably not by screening. It has been found that cement which has been ground to dust with an equal amount of sand goes much further when used for concrete than the same quantity of cement used in the ordinary way. This is doubtless owing to the fact that the sand dust aids in filling the voids. It is also well known that slaked lime, when added to cement mortar, greatly increases the strength of mixtures poor in cement.

WEIGHT OF UNIT MEASURE AND PERCENTAGE OF VOIDS IN VARIOUS MATERIALS.

	Weight of 1 liter.	Per cent. of voids.
Portland cement	1720 g	......
Louisville cement	......	..
Sandusky Bay sand, not screened	1780 g	32·3
Sandusky Bay sand, through 20-mesh screen	1630 g	38·5
Sandusky Bay sand, 20–30 mesh (standard sand)	1570 g	40·7
Gravel, ¼ to ⅛ inch	1510 g	42·4
Gravel, ¼ to $\frac{1}{16}$ inch	1680 g	35·9
Marblehead broken stone (chiefly about egg size)	1380 g	47·0

From the figures given in the above table the composition of a theoretically perfect concrete may readily be calculated. The existence of voids in the cement may be disregarded, since in the process of hardening the cement sends out crystals in all directions, completely incrusting the sand particles and practically filling all the voids which the cement itself contains. Examination of a well-hardened briquette of cement with 3 parts sand, after breaking, with the aid of a lens, will show this clearly.

Suppose, for example, we wish to make the best possible concrete from Portland cement with the sand and gravel given in the above table. We should, of course, choose the unscreened sand and gravel as containing the least proportion of voids. One hundred measures of gravel would require 35·9 measures of sand. As the sand contains 32·3 per cent. of voids, we require 32·3 per cent. of 35·9, or 11·6 measures of cement. The proportions would, therefore, be cement 1, sand 3, gravel 9. It is customary, however, to increase the proportion of mortar (cement and sand) by about 15 or 20 per cent., in order that the coarser materials may be completely coated with the finer mixture. Making this addition, we find the correct proportions to be cement 1, sand 2·8, gravel 7. Allowance must also be made in practice for imperfect mixing, since the materials can never be distributed in a perfectly uniform manner. Practically, with these materials, a concrete of cement 1, sand 2½ and gravel 6 would probably give the best result, and little or no improvement would result from increasing the proportion of cement.

A similar calculation shows that the correct proportions for a concrete made of the sand and broken stone given in the table would be 1 to 3 to 6½. Increasing the amount of cement and sand by 20 per cent., we have 1 to 3 to 5½. Probably 1 to 2½ to 5 would be found to give the best results in practice. The determination of the voids in the sand, gravel and broken stone used is of the greatest value in adjusting the proportions of concrete.

The simplest method of determining this in the case of gravel and broken stone is to have a metal box made of 1 cubic foot capacity; this is filled with the material to be tested, well shaken down and struck off level. The box and contents are then weighed. Water is now poured in until it rises even with the surface, and the total weight again taken. The difference in the weights is the weight of the water filling the voids of the material. Now one cubic foot of water weighs $62\frac{4}{10}$ lb., and from the weight of the water found the percentage of voids can be simply calculated. For example, in one experiment, the box and broken stone weighed 88 lb. After filling the spaces in the stone with water the weight was 117½ lb., a difference of 29½ lb. The percentage of voids is, therefore, $29\frac{1}{2} \times 100 \div 62{\cdot}4 = 47$ per cent.

In the case of sand this method will not answer, as it is difficult to completely fill the voids of the sand by adding water. The voids can, however, be readily calculated from the weight of a cubic foot and the specific gravity. The specific gravity of quartz sand is about 2·65. A cubic foot of sand, free from voids, would therefore weigh $2{\cdot}65 \times 62{\cdot}4 = 165{\cdot}4$ lb. The weight of a cubic foot of sand, well shaken down, was, however, found to be only 112 lb., a difference of 53·4 lb. The proportion of voids was, therefore, $53{\cdot}4 \times 100 \div 165{\cdot}4 = 32{\cdot}3$ per cent. The percentage in voids in clean natural sand does not vary greatly, and may generally be taken as 33 to 35 per cent. for coarse and 35 to 38 per cent. for fine sand.

We have already seen that with the materials above described, concretes composed of

Cement 1, sand 2½, gravel 6, or
Cement 1, sand 2½, broken stone 5

by measure, will be practically compact and non-porous, and that there is no object in increasing the proportion of cement. Such concrete, if made from Portland cement, will, however, be rather expensive, requiring about one barrel of cement (=3½ cubic feet) for every cubic yard. This is unnecessarily good for ordinary work, and will only be required for foundations of engines and other heavy machinery, in which the best possible result must be secured regardless of cost. In cheaper concretes the relative proportions of sand and broken stone should be the same, as determined by the voids in the coarser material, while the proportion of cement may be varied according to the required

* Read before the Ohio State Engineers' Society at the annual meeting, Cincinnati, Jan. 17, 1895.

conditions of quality and cost. Most excellent concrete may be made by using:

Portland cement 1, sand 5, stone or gravel 10, or even Portland cement 1, sand 7, stone or gravel 14.

Here are specimens of these two concretes, taken from trial blocks laid Oct. 1, 1894, to determine the best proportions for the foundation of brick pavement. The richer of the two, 1 to 5 to 10, is certainly good enough for any purpose, even for engine foundations. A cubic yard of such concrete requires about one-half barrel of cement; the total cost of the cement, sand and stone is about two dollars per cubic yard. This is no more expensive than concrete made from Louisville cement with 2 of sand and 4 of broken stone, and is immensely superior to the latter in strength.

The following table shows the results obtained in Germany by R. Dykerhoff, in determining the crushing strength of various concretes. The blocks used were 2½ inches square, and were tested after 1 day in air and 27 days in water.

Proportions by Measure.			Strength under Compression. Pounds per Square Inch.
Portland Cement	Sand.	Gravel.	
1	2	..	2125
1	2	3	2747
1	2	5	2387
1	..	5	978
1	3	..	1388
1	3	5	1632
1	3	6½	1515
1	4	..	1053
1	4	5	1273
1	4	8½	1204

These figures prove the statement already made, that mixtures of cement and sand are strengthened, rather than weakened, by the addition of a suitable quantity of gravel. It will be noticed that the mixture —cement 1, sand 2, gravel 5— is actually stronger than cement 1, sand 2, without gravel. The same is shown in the mixtures 1 to 3 and 1 to 4.

In estimating the amount of material required to produce a given volume of concrete, it may be stated that when very strongly rammed into place the volume of concrete obtained from correct proportions of the material will be about 10 per cent. more than the volume of 1 cubic foot cement, 2½ cubic feet sand, and 5 cubic feet stone, and will therefore yield about 5½ cubic feet concrete.

Much valuable information on this and many other allied subjects may be found in the book "Portland Cement und seine Anwendungen in Bauwesen," published (in German only) by the German Cement Manufacturers' Association.

ROLLED WELDLESS CHAINS—KLATTE'S PROCESS.

THE problem how to produce weldless chains is one which has taxed the ingenuity of inventors for years. The credit of having set about the solution of this problem in a practical manner belongs to Monsieur Oury, of the Cherbourg Arsenal, whose first patent dates from the year 1881. The process devised by Oury consists in the conversion of cruciform bars into weldless chains by means of boring, punching, and forging in dies, both in a cold or heated state, according to circumstances. Later, in place of punching, pressing and forging were chiefly resorted to.

Mr. O. Klatte, the manager of the Walzwerk Germania, at Neuweid-on-the-Rhine, has recently successfully worked out a system of manufacturing weldless chains in which all the tedious operations of repeated heating, forging, and punching are avoided. This is effected by simply rolling the chains. As in Oury's and Rougier's processes, the original form is a cross bar. This is passed between four rolls, of which the working circumferences are beveled, so that the lines of contact when brought close together are at right angles to each other. By means of these rolls the material is squeezed, where not required, inside and between the future links, into a thin web, and what, for convenience, may be called the chain bar is formed, having the shape illustrated at b, Fig. 1, in which a shows the original cross bar.

The arrangement of the rolls will be best understood by reference to Fig. 2, in which a bar is shown during its passage through the rolls with the top roll removed. The conversion of the cross bar into the chain bar is carried out in one heat. After leaving the rolls the chain bar is passed through a punching machine, with automatic feed, by means of which the webs are removed. This is done while the material is still slightly warm. In Fig. 12 the forms of the punches employed are shown. As rolled, the width of the chain links is somewhat greater, and the length consequently somewhat less, than is required in their finished state. In order, therefore, to give them their final shape, the chain bar, of which the links are still connected by a slight web where inaccessible to the punches, is reheated to a red heat and passed under a press, by which the links are reduced to the specified width. The same end can also be attained by the use of finishing rolls, which stretch the links to the necessary extent. In either case the links are finally separated during the operation. The velocity with which the chain bars are rolled depends of course upon the dimensions, and ranges from 10 feet to 20 feet per second.

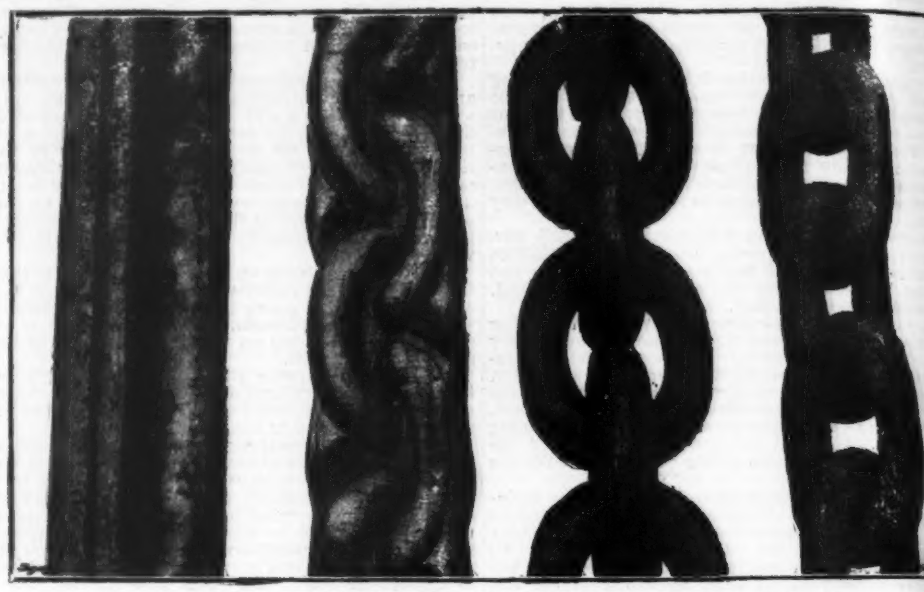
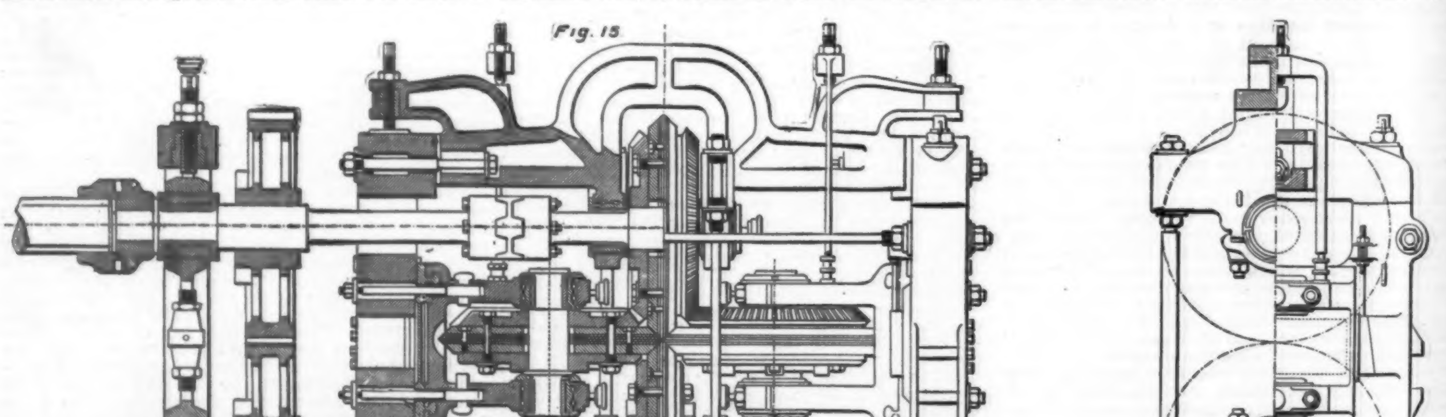


FIG. 1.—THE DEVELOPMENT OF THE CHAIN FROM THE BAR.

Having given the general outlines of Mr. Klatte's process, we now come to the details, upon which, as in every similar case, the success of the invention depends. The detailed construction of one of the rolls is shown in Figs. 3 to 7. It consists of a central disk, secured as shown in Figs. 3 and 4 between two bevel wheels, to the circumference of which are dovetailed and keyed a number of sectors constituting the working portion of the roll in which the dies or matrices are formed.

By removing the key piece, c, an opening is uncovered through which one sector after another can be inserted and pushed into its proper position on the circumference. When all the sectors are in place

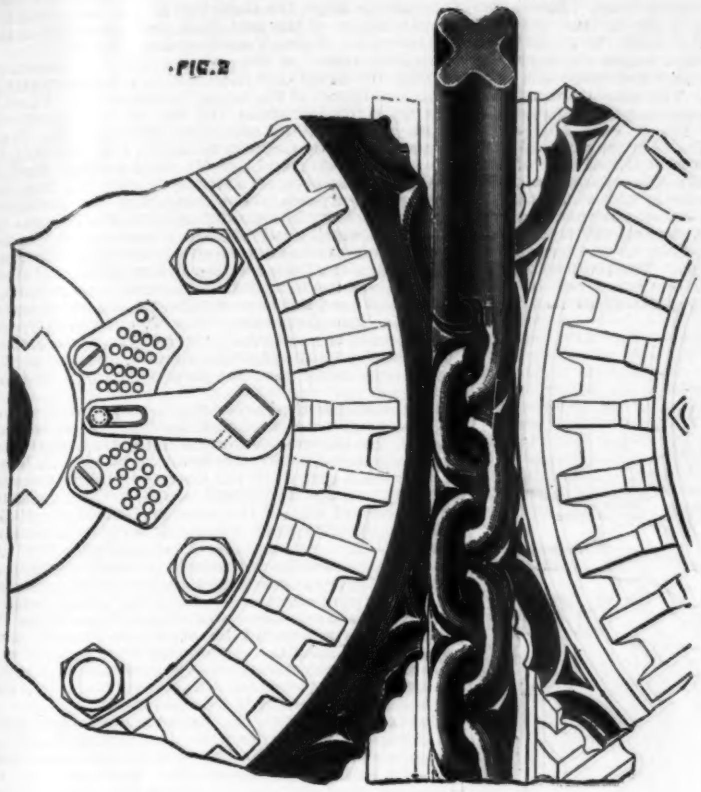


MACHINE FOR ROLLING CHAINS FROM THE BAR.

the piece, c, is again inserted, and the two keys, d, driven in; the latter secure the sectors against displacement. The sectors are in the first place rolled as bars, with the necessary cavities or matrices impressed in them. These bars are afterward cut to the required lengths and fitted, while the finishing of the matrices is effected by cutters, on a machine specially designed for the purpose, of a type similar to those employed in the manufacture of small arms. It has been found that steel with a tensile strength of from 32 to 38 tons per square inch is a suitable material for the sectors. Instead of sectors a complete ring may be used, but for facilitating the renewal of worn or damaged parts sectors are very convenient. Experience has proved that the rolls do not appreciably suffer by use, as with all the trials which have been carried out with one set of rolls, no measurable wear has been observed. This is due to the large diameter of the rolls—from 3 feet 3 inches to nearly 5 feet—and also to their high velocity.

If any supplementary shaping of the matrices is necessary, the rolls are supported on pedestals and the circumference heated to a red heat and annealed. Hitherto, no distortion has been found to result from this treatment. Damaged or defective sectors can

FIG. 2



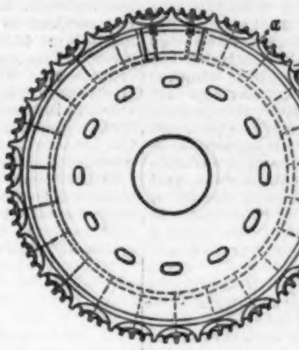


FIG. 3.

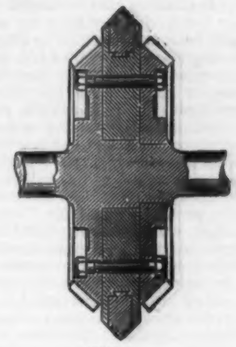


FIG. 4.

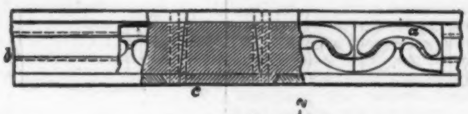


FIG. 5.

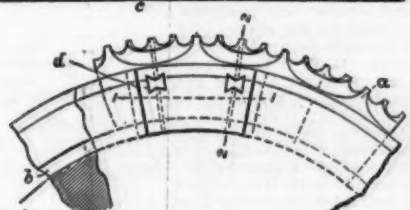


FIG. 6.

FIG. 7.

FIG. 10

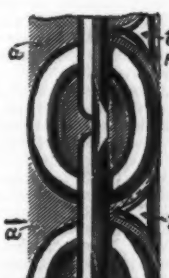
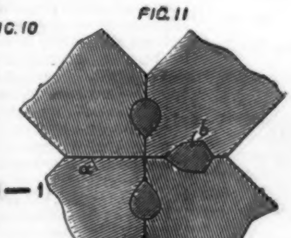


FIG. 11



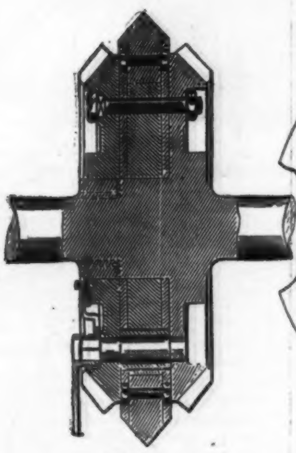


FIG. 8

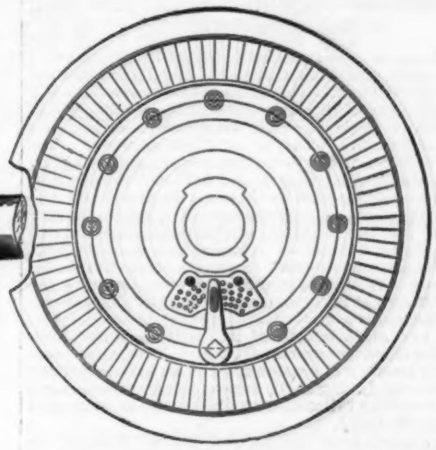
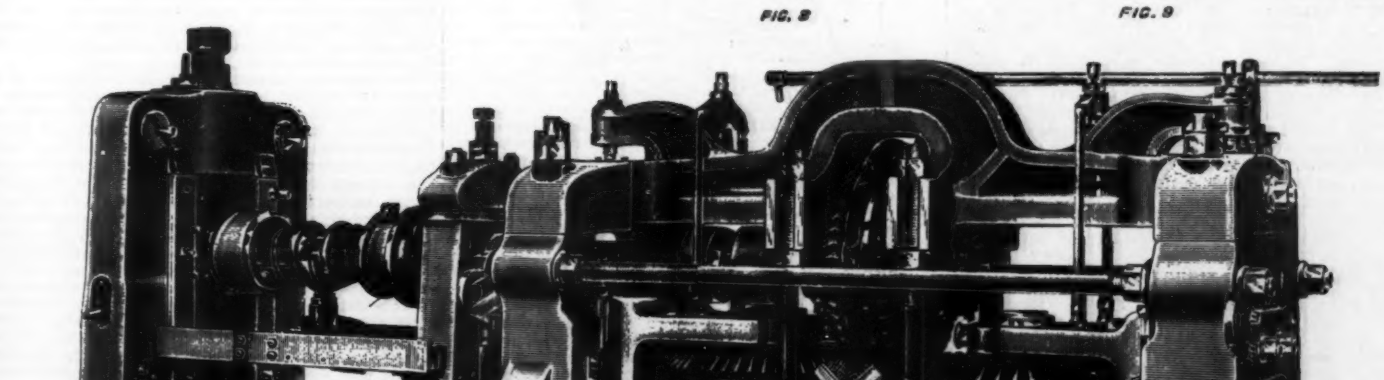


FIG. 9



MACHINE FOR ROLLING CHAINS FROM THE BAR.

easily be replaced. Instead of being fitted together in the manner already described, the sectors may be dovetailed together; there is no difficulty about this. In order to facilitate the adjustment of the four rolls relatively to each other, the device illustrated in Figs. 8 and 9 is adopted. This consists of an eccentric fitting the central disk of each roll, and having its bearings in the wheel plates or webs between which the roll is secured. The eccentric is turned by a spanner, and when adjusted is kept in place by means of a lever and set screw, as clearly shown in the illustrations, Figs. 2, 8 and 9. In the construction of the matrices many points have to be considered, not only with regard to the durability and strength of the projecting portions—or teeth, as they may be termed—but also as to the important part which is played by these teeth in displacing the material of the crossbar. The form of the teeth also depends on the shape of the links, whether long or short. As the corresponding matrices for each link on the four rolls come together, the process of rolling is in reality interrupted, and room must therefore be provided for the lateral displacement of the material. This is effected by means of a suitable distribution of space in the cavities of the rolls, and the inventor has, for instance, in the case of one set of rolls, provided for the "spreading" of the material during the process of rolling by giving the links a larger section at the points of contact, where they are subject to the greatest strain and wear.

As regards the general method adopted, the bloom is rolled in the usual manner into a bar of suitable section for the production of cross steel, having a length of about 50 feet. This bar is reheated in a furnace of corresponding length, and then passed automatically through a series of quadruple rolls, arranged in line one behind the other, and calibrated as shown in Fig. 13, b and c. On leaving these rolls, the length of the bar will have increased to between 98 feet and 130 feet, and it is transferred directly in the same heat to the chain rolls, in which it is finally stretched to from 164 feet to 197 feet. When longer chains are required, special wire chain links are provided for connecting several rolled lengths. The construction of such a wire link is illustrated in Fig. 14. Each of these links has a strength very much in excess of that of the normal rolled links, and is protected by a mantle or sheath of sheet steel.

Fig. 15 is a working drawing of the general arrangement of the rolls, while a perspective view of the latter is shown in Fig. 16. The cost of production by Mr. Klatte's process compares favorably with that of the old method of chain making, and advantages over the latter in other respects are claimed. The machinery as described is being introduced into this country by Mr. G. R. Bodmer, of 30 Walbrook, London.—The Engineer, London.

THE TEHUANTEPEC RAILROAD AND THE WORLD'S COMMERCE.

It has long seemed to us, says the Railroad Gazette, that the most natural first step in the demonstration of the proposition that the nations of the earth need a ship canal between the Atlantic and the Pacific would be to build a good railroad with capacious and safe harbors across the Isthmus of Tehuantepec. This would give to trade between the eastern and western coasts of the United States and between Europe and our Pacific coast, as well as between England and the great Asiatic ports, the advantages of a route shorter than that by the Isthmus of Panama, and a route lying throughout its whole distance in a country with a good climate and offering prospects of profitable local business. With this in mind the completion of the National Railroad of Tehuantepec built by the government of Mexico is a matter of a great deal more interest than the mere length of the railroad would indicate. Therefore, we reprint from the November issue of the Engineering Magazine part of an article written by Mr. Elmer L. Corthell, reproducing also a small map showing the railroad now built and the projected Eads Ship Railroad.

The line starts from the Bay of Salina Cruz, in the Gulf of Tehuantepec, on the Pacific, following the windings of a narrow ravine until it reaches the Zuleta Pass, when it descends to Tehuantepec, a city of 15,000 inhabitants. Thence, in very easy lines, it passes across the Pacific plains to the foot of the ascent leading to the Chivela plains on the table lands. Through the Chivela Canon the road is mostly built in solid rock. The lateral canons or ravines are crossed by iron viaducts constructed by the Phœnix Bridge Company, of Philadelphia. At Chivela the elevation is 790 feet above the sea level, but there is a second summit to be overcome in crossing the Sierra de Niza Conejo (crazy rabbit), where the maximum summit is reached, 924 feet above sea level. The maximum grade up to this point and, in fact, on the entire line, is 2 per cent., and the curvature 200 meters (656 feet) radius, although in order to "join the rails" with as little loss of time as possible and with the least money, there are temporary grades of 2 and even 3 per cent., and some few curves of 100 meters (328 feet) radius. The route across the table lands lies through an ordinary rolling country, the maximum grade of the railroad being about 1·8 per cent., and maximum curvature about 600 feet radius. From the Jumuapa River the road passes through a dense forest for many miles to the Atlantic plains. The maximum grade on this slope is about 1·5 per cent. There are five large rivers to be bridged, the largest being the Jaltepec, on the Atlantic slope, one of the chief tributaries of the Coatzacoalcos. The only tunnel on the line is about 300 feet in length. The material for the roadbed is generally good. The cross ties and other timber were obtained from the United States, those for the Atlantic division coming from Pensacola or Mobile, and those for the Pacific slope from the redwood forests of Oregon, but a large part of the iron work was furnished by Great Britain. The rolling stock is partly American and partly English. Sixty miles from the mouth of the Coatzacoalcos is found suitable limestone rock for harbor works. At Coatzacoalcos there is a well-arranged and suitable terminal station and yard, the building for warehouses and shops being of iron, with corrugated roofs, manufactured in England.

In order to make the railroad valuable as an interoceanic route, it will be necessary to improve the two harbors. The terminus on the gulf is at the mouth of the Coatzacoalcos River, which carries to sea for several months of the year a large volume of fresh water. Its watershed is about 6,500 square miles. The rainfall is quite regular, in its seasons and in its amount, so that it may be depended upon to give a sufficient velocity for excavating and maintaining a deep channel through the bar in the gulf at the mouth of the river. About five miles below Minatitlan, on the opposite side of the river, the largest tributary, the Uspanapa, discharges into the main river. Below the mouth of this tributary, at a point in the straight reach of the river, where the width is about 1,000 feet between banks, the average maximum depth on the sections is about 70 feet and the cross sectional area about 40,000 square feet. The magnitude of this river will be appreciated by a comparison of its area of cross section with that of the South Pass, Mississippi River, which is 24,000 square feet. It may be said that there is inside of the headlands at the mouth of the river a continuous harbor at least ten miles long. In the area immediately at the mouth, and which will be used for harbor purposes, the 30 foot channel is about 1,000 feet wide and the 40 foot channel 850 feet. The shore on the left bank of the river at the terminal is nearly straight for about a mile. The river enters the gulf between two headlands, one composed of sand dunes and the other of solid land about 60 feet high.

THE TEHUANTEPEC RAILROAD.

The persistent fresh water flow excavates a deep channel through the bar at the mouth of the river.

As to the sea forces available for maintenance, their magnitude and constancy may be appreciated by their action on the outer slope of the bar, preventing its advance, although there is poured into the sea by the river during the rainy season an immense amount of sedimentary matter. This outer slope, if measured on the line of the proposed channel and between the 18 foot and 44 foot curves, is about 1 in 100, which is a steeper slope than that of any of the other large rivers along the coast of the Gulf of Mexico, except that of the South Pass of the Mississippi as it existed before the jetties were built. These conditions are very favorable for economical construction and maintenance, since the combined action of the river and the sea, one behind and the other in front eroding the bar, greatly reduces the length of the works and the contents of the prism to be excavated by the currents. The plans proposed contemplate parallel jetties extending 4,500 feet from the shore to about 24 feet depth in the gulf; the distance between the jetties to be 800 feet. The material in the permanent structure will be entirely of rock. As this harbor is to be used for a great interoceanic traffic, where the largest class of vessels will enter, a channel less in depth than that at New York or New Orleans should not be considered.

As to the maintenance of these works, it is believed that jetties, constructed on the plans adopted—based upon an examination made by the writer of the jetties at the mouth of the Maes, in Holland, where there is at times a much more severe exposure to waves than at any point on the Gulf of Mexico—will be able to withstand the waves from the northers, which blow with great force across the gulf from the Texas coast and are quite persistent during the winter. As the question of the existence of wind or littoral currents for maintenance of the channel and the erosion of the outer slope of the bar is such an important one, it should be stated that there is a pronounced and constant sea current, with a velocity of from one to three miles per hour, entering the Gulf of Mexico between the Peninsula of Yucatan and the Island of Cuba; this current hugs the shore line all the way along the concave shore of the mainland, past the mouth of the Coatzacoalcos River, Vera Cruz and Tampico.

An observation of the existing physical conditions justifies the belief that there will be a recession rather than an advance of the bar at Coatzacoalcos. There is now upon this bar about 14½ feet of water, and the depth is well maintained and has little variation. From surveys made by Captain Shufeldt, U.S.N. (1871), by the writer (1881), and by Mr. Ripley (1892), there is shown to have been no advance of this bar into the sea for twenty-one years past. The sea and river forces have been in equilibrium, and the bar has decreased in width about 400 feet. Inside of the harbor it is intended to build a wharf of creosoted timber and piles or of steel, 2,000 feet long, parallel to the shore. The slope of the bank into deep water is so steep that this wharf need not be more than 100 feet wide from the shore line into deep water. It is intended to equip this wharf with the necessary tracks, warehouses, and a complete hydraulic plant for handling freight quickly and economically from the ship to the cars and vice versa.

On the Pacific the harbor works will consist mainly of a breakwater of broken stone coped with concrete blocks. The slope of the shore under water is quite steep and deep water is therefore near at hand. . . . There is a constant surf upon the beach of sufficient magnitude to swamp any small boat except during the prevalence of one of the strong northers of winter, when but little surf exists. It will be necessary, therefore, to form a protected and quiet harbor. All freight must now be put ashore by small lighters, resulting in delay and in expense which is often as great as the entire freight rate of sailing vessels between San Francisco and Liverpool around Cape Horn. To hope that vessels would lie at a pier in such a sea would be idle, and the expectation that any ordinary pier would stand such wave exposure would meet with early disappointment in the loss of the pier, even should the waves permit its construction.

It is estimated that the jetties and auxiliary works at Coatzacoalcos harbor will cost about $2,250,000 and the proposed terminal wharf and its equipment $360,000, the Salina Cruz breakwater $2,700,000, and the terminal piers and dredging $385,000, making a total for the harbors and terminals of $5,695,000 (gold). The contract for railroad work terminated in September. What it will cost to make the necessary betterments for interoceanic business in the way of reducing grades, improving curves, widening cuts, proper ballasting, equipment, and other expenses, it is difficult to estimate. Probably $2,000,000 would be sufficient to begin a good interoceanic traffic, so that the total estimated cost after September for the harbors and railroad, exclusive of interest during construction, would be about $8,000,000 in round numbers.

The commercial features give rise to questions that are of great moment and far reaching. Commercial movements are in such delicate equilibrium that a disturbance of any kind, an improvement of a route or the opening of a new one, may affect the entire commerce and with it the industries of the world. Take the tea trade for which the Suez Canal and the transcontinental lines of the United States are contending. In 1884, 49,964,482 lb. of tea reached the Atlantic coast of the United States from China via the Indian Ocean, the Suez Canal, the Mediterranean, and the Atlantic, while 18,256,764 lb. came across the Pacific via the transcontinental lines to the country east of the Missouri River. But the San Francisco route is gaining. In 1890 the amount of tea received via Suez had decreased to 43,000,000 lb., although the total amount handled had increased enormously. At the same time the amount handled by rail had increased to 39,000,000 lb. It is necessary, therefore, to study the increase, as well as the general movements on the various routes of the entire traffic of the world.

The aggregate commerce of the five principal maritime nations—the United States, Great Britain, Germany, France and Spain—increased 20 per cent. in the last decade, the annual increase averaging 2 per cent. Probably this rate would be diminished by including the returns from all other nations. It is safe to estimate the annual increase of the commerce of the whole world during the present decade at 1 1-10 per cent. at least, and this figure is used in the estimates which follow. From the sources mentioned tables have been compiled showing the number and registered tonnage of vessels engaged in trade between the ports of twelve countries and the ports of twenty distinct countries on the Pacific and Indian Oceans in 1890. Other tables show the commerce on still other routes. Analyses have been made of the amount of freight constituting the transcontinental traffic between the Pacific and points east of the Missouri River, with details of the freight carried from seaboard to seaboard; even the passenger traffic has been carefully investigated, that transported on certain routes in 1891 being compared with estimates of the percentage and number that would travel in 1896 via the Tehuantepec route, between Australia, Honolulu, China and Japan to Europe, Pacific, Mexican and Central American ports to Europe, San Francisco to New York via Panama and vice versa, the westward movements, and other, though perhaps less important, travel between Cuba and China via New Orleans; passengers via the Suez Canal and local passengers from all points on the western coast of Central and South America to points east of the isthmus on the gulf and Atlantic. The time required for freight by various routes and the estimated time via Tehuantepec has been carefully investigated.

As an illustration of the importance of this examination, take the following summary as between the representative termini of New York and San Francisco, in which is given the actual time consumed in days and the distance in statute miles, equating the ocean and rail distance by multiplying the latter by 3;

although, if the equation is made on the basis of the real comparative cost, 5 rather than 3 should be used;

Routes.	Number of Days.	Miles.
Around Cape Horn (by sail)	140	15,420
Via Straits of Magellan (steam)	60	13,090
Via Transcontinental lines (fast freight)	25	10,203
Southern Pacific to New Orleans (rail). New Orleans to New York (steamship, fast freight)	14	9,386
Via Tehuantepec	20	4,280

One of the most important reasons for opening the Tehuantepec route will be seen by comparing the time and distance of the all-rail routes with the time and distance of the half rail and half ocean routes by way of New Orleans. In these simple figures lie the main reasons why the Southern Pacific and Morgan Line route via New Orleans has been able to obtain from 75 to 90 per cent. of our entire transcontinental traffic. Now, if the fact that this route is one-half water has given it such an immense advantage over the all-rail lines, may we not expect that by carrying this principle further and uniting the two coasts by a practically all-water route on the shortest possible line, we may obtain some of the immense traffic between the Atlantic and Pacific coasts and interior of the United States? May we not further expect from the new and extraordinary facilities given to this country, and particularly to the ports of the Gulf of Mexico, we may develop an entirely new coastwise traffic between the southern and eastern coasts of the United States and Mexico and the Pacific?

Freight rates by all the various routes and of different classes of freight have been studied for the purpose of determining a reasonable charge for transportation via Tehuantepec. The highest and lowest freight rates in 1891 on the eastern and western routes of the world for representative cargoes have been followed in great detail for the purpose of forming a reliable judgment. The varied questions of the present increase of traffic on all the main routes between the various countries and for various products have been investigated, and these results applied to the proposed route of Tehuantepec. The estimate of the commerce that will be handled by the National Railroad of Tehuantepec has been based upon (1) the annual increase of the world's commerce, (2) the traffic of the season of 1890-1891, and (3) the time fixed for opening up the route (1896). The traffic figures are based on freight tonnage, the rates being on the basis of the weight of commodities and not the registered tonnage of vessels. Instead of quoting a meridian of longitude as the boundary of the "attractive influence" of the Tehuantepec route, the actual reports of shippers and recognized facts, and the trend of commerce, have been taken to show the extent of this influence. It has been properly considered in the estimate that the saving in distance and time by the Tehuantepec route means that by a shorter route a large number of voyages per annum can be made and consequently greater return to the vessel owners on their investments, and, in addition to this saving, an increase of annual earning capacity of vessels. By the use of the shorter route there would be the saving in the wear and tear of craft by avoiding the stormy routes by Cape of Good Hope and Cape Horn, also smaller cost of insurance and a general diminution of running expenses. It has also been taken into consideration that sailing vessels could use this route, while it is impracticable for them to use the Suez Canal, on account of the impossibility of navigating the Red Sea, or to use the Panama route on account of unfavorable nautical conditions in both oceans.

The writer contends that the great advantages—geographical, physical, nautical and commercial—of the Tehuantepec route over Cape of Good Hope, Suez Canal, Cape Horn, Straits of Magellan, Panama, Nicaragua and the transcontinental lines, would enable it to divert to itself and create a combined aggregate tonnage of great magnitude, and that this route can successfully compete with any of those above mentioned, including Nicaragua, which is considered (erroneously in the opinion of the writer) to possess great special advantages. But the writer also knows that the Tehuantepec route must, in order to compete successfully, be fully equipped in extensive terminal and wharf facilities and be operated on the lowest possible grades permissible, with the easiest curvature, with a sufficient equipment of rolling stock and in close connection with its own steamship line on the Pacific and the Atlantic, with harbors on both sides accessible to the largest ocean vessels under all conditions of weather.

On the above basis a summary of the detailed estimate shows that there may be reasonably expected in 1896 a total through traffic of 5,288,037 tons, and that the gross receipts, with the addition of the passenger business and the local traffic on the isthmus from the adjacent and already rapidly developing country, would amount to over $10,000,000 (gold).

The importance to the United States and to all other maritime nations to provide an interoceanic route, the approaches to which are favorable for sailing vessels, cannot be overestimated. Mr. Romero has given a brief comparison of nautical conditions at various points on the American isthmus, which shows the impracticability of sailing vessels using the more southern routes on account of persistent calms and unfavorable winds in both oceans, and the entire practicability at Tehuantepec, on account of favorable winds. The world's tonnage that will be affected by an interoceanic route is larger in sail than in steam. In the fiscal year 1892-93, the fleet employed in trade between European and United States Atlantic ports and between Australasia and the Pacific coast was made up as follows:

	Steam.	Sail.
Register tonnage	2,535,202	3,958,891
Equal to cargo tonnage	3,250,000	6,400,000

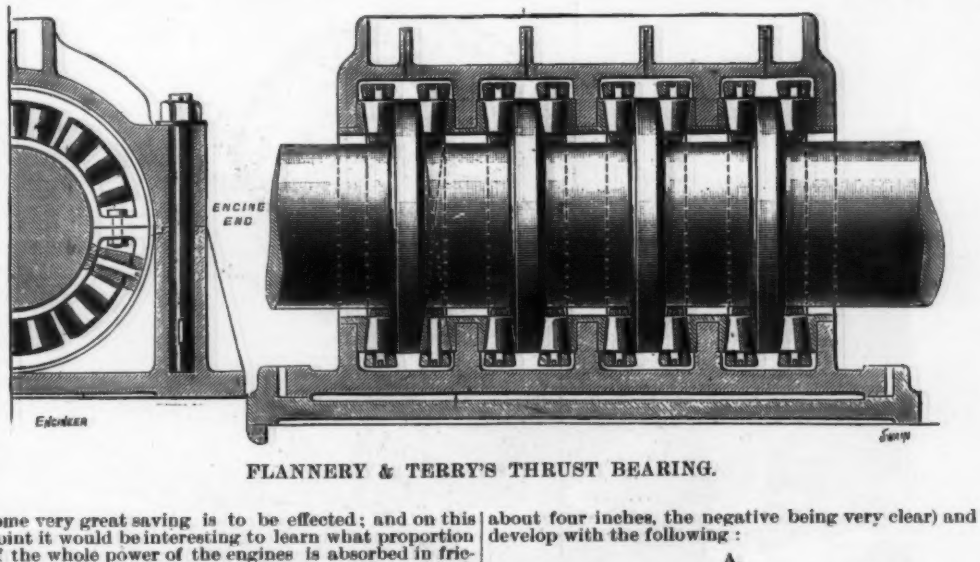
In conclusion it should be stated that, by the wisdom and far-seeing policy and the persistent efforts of the president of the Mexican republic, not only the railroad, but the harbors, terminal facilities, and sufficient equipment, and all that is above outlined, will be provided within the next three years. The opening of this interoceanic route for the benefit not only of Mexico, but of the world, is one of President Diaz's cherished objects. The question now is, Into whose hands will this important route fall for operation and control? Shall it pass to Europeans or to citizens of the United States? The country the citizens of which shall operate it will have for the next century a commercial advantage that cannot be overestimated. By whomsoever operated, this route is certain to effect a revolution more far reaching and more important to the commerce and industry of the world than that which followed the construction of the Suez Canal.

IMPROVED THRUST BEARING.

WE give an engraving from the Engineer, London, of an improved thrust bearing for the shafts of steamers, designed by Mr. Fortesque Flannery and Mr. Stephen H. Terry, who say:

In our system the straps revolve at half the speed of the shaft, and we provide that the whole shall work in a bath of oil. To simplify construction we have rollers on the ahead side only, thus saving nearly half the space and weight; but, even with this reduction, the apparatus costs more than the ordinary thrust blocks, and adds to the number of moving parts, and, although it substitutes rolling for rubbing friction as far as the peripheries of the rollers are concerned, it reintroduces a considerable part of that rubbing friction at the outer ends of the rollers, in consequence of the necessary angle at which the surfaces receiving the pressure are placed.

I believe it is possible to design on these principles a thrust bearing which would reduce friction considerably, and stand Atlantic mail service usage; but, as a general rule, inventions which complicate instead of simplifying designs are difficult to get adopted, unless some very great saving is to be effected; and on this point it would be interesting to learn what proportion of the whole power of the engines is absorbed in friction by the thrust block. If the type of thrust block in use to-day is to be displaced, I hardly believe that it will be by rollers.



FLANNERY & TERRY'S THRUST BEARING.

PHOTO-ENGRAVING WITH SILVER SALTS.

By LEON WARNERKE.

THE process which I have to communicate is, I believe, but little known, although it is about fifteen years old. When it was originally introduced, the photo-engraving processes were not in vogue; but since that time mechanical printing processes having been brought to a great degree of perfection, greater attention has been given to the subject, and I think the time has come to give a full description of this process, which I have never done before. The process is based upon the following principle: A gelatino-silver emulsion is coated upon paper in a manner similar to the preparation of carbon tissue, except that a salt of silver (bromide or chloride, or a mixture) takes the place of the pigment; the sensitized paper is exposed behind a negative and developed with pyrogallol and ammonia (no other developing agent is suitable), whereupon the portions of the emulsion which have been acted upon by light and subsequently by the developer are rendered insoluble, and the unaffected parts can be removed by treatment with hot water as in the carbon process, the print being then in a condition to be used in the manner usual in the processes of photo-engraving. It can be applied equally well for either letter press or copper plate printing. My method differs from the processes now in general use in that no salts of chromium are employed, but salts of silver; and, secondly, because, instead of a prepared metal plate being exposed behind the negative, and afterward developed with hot or cold water, in this case the paper tissue is exposed, developed with pyro and ammonia, and then transferred to the metal plate.

This mode of procedure permits the contact between the glass negative and the paper tissue to be secured much easier than between the glass negative and metal plate, and renders unnecessary the reversal of the negative.

As the ink used in copper plate or letter press printing is not capable of producing half tones in the finished picture, the tone gradation must be secured by some other means, and is generally secured by a system of dots or points of different size. There are several methods of producing this grain. One method very largely employed at the present time consists in taking the negative through a screen of finely ruled glass; a second is by dusting powdered asphalt upon the metal plate, and afterward developing the image upon the plate so prepared. For letter press work, of course, a negative only is required, but if the copper plate process is employed, the transparency must be a positive. For the purpose of this demonstration I propose to use a portrait of our president, having obtained by his premission an albumen print from Mr. H. S. Mendelssohn, the author of the portrait, from which I have made a negative through a screen produced by Levy, of America, and having 133 lines to an inch. The screen consists of two plates, ruled each in different directions and cemented together so as to form practically one piece of glass; it is placed in the special carrier in the dark slide and in contact with it is placed a sensitive plate. I used the ordinary gelatino-bromide plate; on this occasion it was a plate prepared by Messrs. England—slow, but very clear.

To illuminate the portrait I used my favorite magnesium lamp, and I find that the interposition of the screen between the plate and the transparency increases the exposure necessary by about three times. For producing the negative, which I pass round for examination, thirty inches of magnesium ribbon were burnt, half on one side of the frame and half on the other, lens f/11. It is very important that the glass screen should be perfectly clean, as the network is so fine that the slightest dust upon it will render good results impossible.

I will now proceed to work the process. The negative which you have seen is placed in the printing frame, with a piece of the sensitized paper, and the metal plate is next prepared. I used a copper plate, but brass would do as well. I have succeeded in obtaining a fine-surfaced copper plate requiring very little polishing, and which does not produce the "devils" which are sometimes met with in process work. Snakestone followed by charcoal is used for polishing the plate, which should be placed upon a board covered with thick felt to prevent slipping, and after the polished plate has been washed it is ready for transfer. I now make the exposure by burning a sufficient length of magnesium ribbon (in this case about four inches, the negative being very clear) and develop with the following:

A.

Water	100 parts.
Pyrogallic acid	10 "
Citric acid	1 "

B.

Water	100 parts.
Ammonia	12 "
Potassium bromide	4 "

To develop, carefully measure 10 drops of A and 14 of B, add about 45 c.c. of water. Wash the exposed tissue in order that the developing solution may flow freely over it, and apply the developer, mixing a fresh portion if it becomes discolored. If the development is prolonged, it is necessary after developing to neutralize the last trace of ammonia with acetic acid in weak solution, or the emulsion will be rendered too insoluble on the surface. The print, being developed, is squeezed into contact with the copper plate. It is a good plan to press in this stage for one instant in the copying press (not too strong).

At this stage the manipulations do not differ from those of the carbon process, except that the carbon tissue requires to remain for at least a quarter of an hour before development is proceeded with; in this case hot water is applied almost at once, and the paper removed, leaving the emulsion on the plate. The unaltered silver is then washed out with warm water (about 30° C.) exactly as in the removal of the pigment in the carbon process. When this is completed the image is seen to be formed of very fine points, like needles, and they are swollen, and if they were dried slowly in this condition, little filaments would remain between them.

It is therefore requisite to cause these swollen points to shrink, and this is done by the application of alcohol first diluted with half of water, and followed by the strong alcohol—ordinary methylated spirit will do. The plate is then ready for etching. It is better to allow the plate to remain for several hours to get thoroughly dry, as damp gelatine is easily affected by the etching solution.

A different class of grain is produced by the use of asphalt in the dusting box, the construction of which is shown in the print which I pass round, and a similar effect can be obtained by dusting the plate with asphalt powder from an India rubber ball or bellows. The plate with the asphalt deposited upon it is placed upon a stove or heated over a flame in order to partially melt the asphalt and cement it to the plate.

The copper plate while heated changes color, and when it acquires a steel color the plate is in proper condition, and after the plate is cooled the image can be developed upon it. Observe that the image upon

the plate is not fixed with hyposulphite of soda in the usual way, as the hypo dissolving the silver salt in the emulsion would silver the plate, which is not desirable. The etching is performed by solutions of sesquichloride of iron of different strengths, those which I use being respectively 45°, 43°, 40°, and 37° Baume. The strongest solution is applied first for ten minutes, afterward the second and third for the same time, and finally the 37° for fifteen minutes. The gelatine is removed from the surface with a solution of a caustic alkali, and the plate is then finished and ready for printing from, except that it is sometimes necessary to remedy some imperfection or etch certain parts more deeply. The cliches which I shall show you and print from have not been treated in this way, but are just as they were etched when removed from the etching solution.

There is no absolute necessity to make a negative through the ruled screen. An ordinary negative can be taken, and the ruled screen on the film put in contact with it, and this printed on the argentic tissue and treated as previously described. In order to secure the utmost sharpness, no glass should be interposed between the negative and screen, or argentic tissue, and for this reason either the negative or the screen must be on the film.

In the course of his paper, Mr. Warnerke demonstrated the details of the process, and concluded by pulling proofs from the plate which he had prepared from the president's portrait. He also exhibited the various materials used, and a number of negatives, engraved plates, and prints.

A vote of thanks was passed to Mr. Warnerke.—Read before the Royal Photographic Society.

THE NARRAS.

THE narras (Acanthosicyos horrida), of which a figure is given, is one of the most remarkable plants known. It is a gourd which forms a spiny bush as high as a man, never has any leaves, bears large orange-shaped edible fruits and seeds which are as delectable as the best of almonds. It is a native of Damaraland, the home of the welwitschia and other anomalous forms of vegetation, where it grows in pure sand in regions where there is never any rain, and where the heat is often so intense that it causes the finger nails to curl. The plant is in cultivation at Kew, but it never grows to any size, and generally succumbs to the fog and darkness of our winters. The natives are said to be passionately fond of the fruit and seeds, crowding down to the coast region, where only it thrives, during its fruiting season, and almost living, and growing fat upon it, carrying away with them for future consumption sacks of the seeds, which retain their sweetness for a considerable time. They are even sent all the way to Cape Town and sold as "Boter pitgies," butter seeds. I have tasted some which had been sent as seeds to Kew and were as palatable as sweet almonds. As many as two hundred fruits have been counted on a single plant by a French missionary, Pere Duparquet, who lived many years in Damaraland, and who stated that without the narras the existence of man would be impossible there. Darwinists are interested in this plant because of its extraordinary adaptation to the trying circumstances under which it has to thrive, and of its extreme difference from the other members of the order; cultivators are interested in it because it looks like a plant which ought to grow well under ordinary stove treatment, but so far has baffled all attempts to establish it outside of Damaraland; chemists have lately paid much attention to it because of its fruit being the best of all vegetable rennets.—W. Watson in the Gardeners' Magazine.

THE NARRAS (ACANTHOSICYOS HORRIDA).

A ROMAN VILLA AT DARENTH, KENT.

A DISCOVERY has just been made which is likely to prove of considerable archæological interest. It has long been known that Roman remains of some description were lying buried in a field to the south of Darenth Church, Kent, for, on the testimony of some local authority at the time, the spot was marked years ago on the ordnance maps. Nothing, however, was apparent above ground, nor did any inequalities in the site warrant the belief that any foundations existed there. Nevertheless, when the summers were dry and attentive examination was given to the corn growing in the field, it would be noticed that there were peculiar irregularities in the crop, and that these were in regular lines, crossing and recrossing one another.

A few years ago, a steam plow was set to work in the locality, but it has now been remembered that some obstacles in the ground broke the instrument, and its use was discontinued. Still later, in clearing out the sloping bank of the river Darenth, which skirts the field, for watercress beds, some foundations were met with in the water, and Roman tiles and mortar were thrown up with the excavated soil.

A fortnight ago, Mr. E. A. Clowes, whose old mansion, bounded by still more ancient red brick walls, is not far from Darenth Church, was tempted to make a tentative excavation on the supposed site of the buried remains, in concert with his friend, Mr. Marchant. Having obtained leave of the tenant, Mr. J. M. Burtenshaw, a trial hole was dug. It resulted in a portion of a Roman pavement of small cubes of red brick being laid bare, but a small depth below the present ground level. Curiosity being naturally excited, it was determined to undertake some systematic exploration, which the nature of the field now lying bare after the autumnal harvest very much favored. Consultation and conference with some known antiquaries having taken place, it was resolved to invite the aid and help of Mr. George Payne, F.S.A., of Rochester, who at once devoted himself to the task of superintending the proposed work.

A body of agricultural workmen, who were glad of the unexpected work in this dull season of the year, was readily obtained and set to work in a space fenced in for the undertaking. The foundations of massive walls were speedily encountered, and the excavators followed them from point to point. It soon became apparent that the building, the site of which was thus being laid bare, was of great extent, and room after room, baths and corridors, were met with in all directions.

We accepted a private invitation on Saturday last to inspect the discovery, and were greatly rewarded by the examination. A portion of the field 300 ft. square was fenced off, and within this a large number of excavators were at work. The extent of the building may be judged by the fact that many of the walls had been traced quite up to the boundary, and their extremities had not been found, while it was clear that they extend beyond the inclosure. Indeed, their extent may prove to be enormous, for it is now an established fact that the field in which the steam plow could not be used is not where the work is now going on, but in the adjoining one.

The remains laid bare lie fairly east and west, the walls being at right angles to each other. To the north is a well-defined hypocaust, with the entrance from an adjoining chamber, formed by a small semicircular arch, with neatly-turned flat tiles, having smaller ones arranged as a label around it. The flues spread out in the hypocaust, and are carried by circular pipes in the walls upward to heat the chamber above once existing.

To the south a large L-shaped room practically inclosed the hypocaust, and here was a detached pier of masonry. Beyond it two large rooms were apparent by the floors still remaining of red tesseræ. They had been divided by a thin partition, possibly of studwork, the skirting of plaster shaped to a quarter round still remaining on each side with the clearly-defined thickness of the partition between them. Elsewhere the skirtings were very apparent, and in several places the walls still remain to a height of more than a foot with the plaster still remaining upon them; indeed, in more than one place the plastering was found remaining, although the wall once behind it had been removed for its materials. Beyond these two rooms, still going west, is a wide corridor 42 ft. 7 in. long from north to south.

To the east of it is another hypocaust, and to the west, parallel with the corridor, is a wide range of walling covered with remains of small tile pillars (pylæ) which once supported the floors of the rooms above, affording space for the passage of hot air from the adjoining hypocaust. Still going west, at the south end of the corridor, a fine series of baths have been laid bare. These are at different levels, one lower than the other, there being a descent to it by five cemented steps, the whole width of the apartment, but it is possible that the present depth is of later work.

This is the case in the bath to the east, where the original floor level is apparent. But there is a curious trench in this bath, as if for the feet only of the bathers. The bath with the steps has had a flooring of large flat tiles, of which a considerable portion still remains, and the impressions of those removed are visible in the mortar bed.

The walls are here and there still covered with plastering, which preserves its deep red color, and the rounded skirtings are also visible. Beyond the baths the excavations extend within easy distance of the boundary, and at closing time the men were unearthing what appeared to be another hypocaust.

To the south of the range of buildings thus described, a width of the site appears to be clear of buildings, but a thick wall, built of two thicknesses and filled in with rubble, has been laid bare from its eastern limit. It extends, apparently, without a break for about 90 ft., where it is stopped by the apex of a semicircular apse. The side walls of the building, of which it formed a portion, have just been laid bare, but they have not been traced. It is likely that they extend beyond the boundary. At a right angle, or nearly so, to the thick wall is another not so massive. It has been followed for a length of about 80 ft., and its eastern end found, but the western termination has not yet been reached, although it has been laid open for about the same length.

It would seem from present appearances that this wall is connected with another series of rooms, while beyond it on each side are other apartments, now being excavated.

The walls are built of flint with a very liberal amount of flat tiles, some of which are of large size, one which we measured being 15 in. by 11¾ in. and 2⅛ in. thick. The mortar is fairly good; pounded brick has been used in it only here and there. A great quantity of colored plaster fragments from the demolished walls has been met with, the colors being red, white, white with patterns of red, buff and black. Great quantities of broken pottery, mostly of black ware, have been found, but at present no very remarkable fragments have been met with. Only a little red ware, pseudo-Samian, has been dug up; and there are many indications that the rooms laid bare are not the principal ones of the establishment.

A few coins of Tetricus and Constantine the Great, small, third brass; many fragments of window glass; a good glass bottle; a great many iron nails of large size; tools, spear heads, oyster shells in large quantities; and a few bone pins are the principal articles that have been found at present, the most interesting object being a piece of bronze with a pattern, the compartments of which are filled in with colored enamel. In one part of the building there is a wide drain formed of flanged roofing tiles, and elsewhere the arrangement for bringing the hot air from the hypocausts by square flue tiles is very perfect. The building has been roofed with large flat tiles of great thickness and weight, and the joints covered with small half-rounded tiles.

The walls have been demolished systematically for their material, and all reduced to a similar level, which was doubtless that of the rubbish of the demolition. This is evidenced by the fact that only a few of the roofing tiles have been met with, which would not have been the case had the roofs fallen in. Abundant evidences remain of the use of the hypocausts by the black ashes, but there is no evidence, as is often the case, that the building met its fate through burning.

The results of the excavations thus far already enable some comparisons to be made with other well known Roman villas. The fine villa in Spoonley Wood, Gloucestershire, recently described by Prof. Middleton, is contained in an area about 190 ft. by 170 ft. The principal portion of the Chedworth Villa, in the same county, is within a space 110 ft. by 60; but there is a wing in addition, and perhaps there is another. The great villa at North Leigh, Oxfordshire, is very nearly the same size as the inclosure set out at Darenth, and no principal part seems to have extended beyond it. The Bignor Villa is about as large as the inclosed space. The Woodchester Villa, without doubt the finest as well as the largest that has yet been opened, has its principal portion in less than the inclosure, although its subordinate parts go out far beyond. It will thus be seen that the discovery at Darenth at once shows that it can be compared with the largest known examples, and that there is every probability of its exceeding them. On Saturday there were a good many visitors within the inclosure, but they served only to show the great size of the building laid open.

The site is easily found. It is about a mile and a quarter from the Farningham Road Station of the London, Chatham and Dover Railway. A visitor has to make his way to Darenth, where, on crossing the river, which is here in two streams at the village, he had better proceed to the church. A path just to the west of it leads along the edge of the river to the field containing the site, where the mounds of earth thrown up by the excavators at once indicate the inclosure, which is about a quarter of a mile due south from the church.

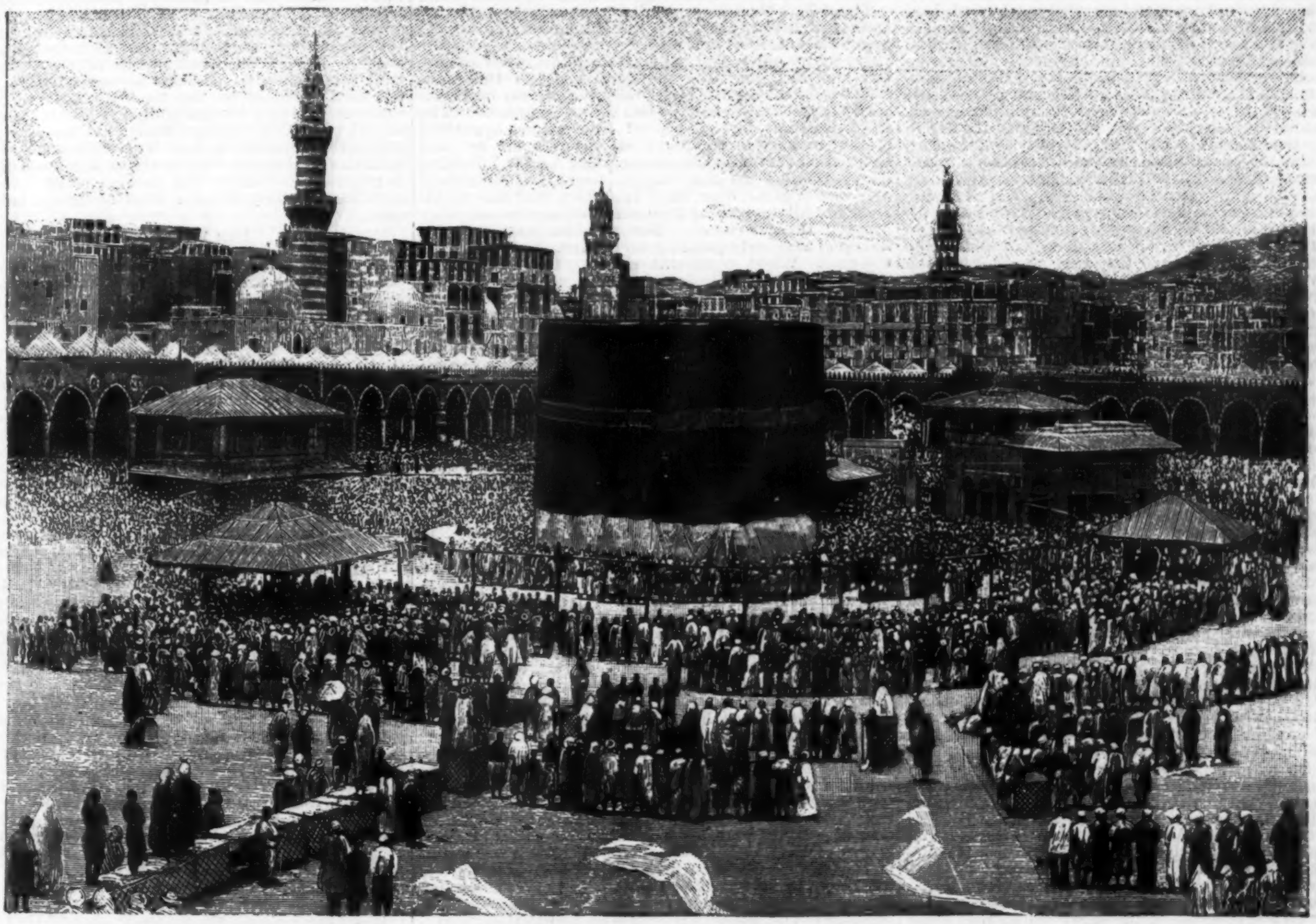
A fee of one shilling is charged for admission, which is devoted to the excavation fund, and for this sum the visitor is permitted to watch the progress of the excavations, every hour adding to the evidences of the extent of the remains. It may be added that Darenth Church shows clearly that all its oldest portions have been built with Roman materials, doubtless derived from the site now being excavated. The nave, from its height and its rude construction, in singular contrast to the early Normal chancel, is, most probably, of Saxon date. The east end is well known for its curious triplet of Norman windows. The south side

and the southwest tower are of late twelfth century work, in which old Roman material has again been used. But the northwest and the northeast angles of the nave and the walling between them are all of Roman brick and flint. There is a rude doorway under the west window, blocked, and an ornamental Norman doorway, also blocked up, evidently an insertion, is visible in the north wall.—The Builder.

MECCA AND ITS GRAND MOSQUE.

MECCA, the chief town of the Hijaz in Arabia, and the great holy city of Islam, is situated about 45 miles due east from Jidda, on the Red Sea. Mecca lies in the heart of a mass of rough hills intersected by narrow valleys and passes, and is situated at the intersection of several important roads, which may account for the commercial importance of Mecca. The town was already well known in the East before the days of the founder of Islamism, but the victory of Mohammedanism effected a great change in the position of Mecca, and the influence of the holy city was soon felt wherever the new religion had penetrated; and in the dual role of pilgrimage and trading city Mecca obtained an important position during the middle ages.

The prestige of Mecca has decreased somewhat in modern times. The city has a fixed population of 50,000 or 60 000; but estimates on this point are not of much value on account of the immense floating population. The vast influx of pilgrims at certain times of the year in a city like Mecca, with its crooked lanes and with no provisions for cleanliness, always makes it a dangerous center of infection, and many of the outbreaks of Asiatic cholera can be traced to this source.



THE HOUR OF PRAYER BEFORE THE KA'BA IN THE GRAND MOSQUE AT MECCA.

The great mosque and the Ka'ba are the chief objects of interest in Mecca. Our illustration represents the great courtyard of the mosque and the Ka'ba. There are more than 500 pillars in all in the mosque. Before the time of Mohammed the chief sanctuary of Mecca was the Ka'ba, a rude stone building, so named from its resemblances to a huge die of about 40 feet cube. In reality, however, the structure is not a cube, and is not exactly rectangular.

The Ka'ba was "purged of idols" by Mohammed, and rebuilt, but the old form was preserved in the main, so the "Ancient House," as it is termed, is still, in all essentials, a heathen temple. The clumsy fiction was promulgated that it was built by Abraham and Ishmael, by a divine revelation, as a temple of pure monotheism. The principal object of veneration is the ancient fetish of the black stone, which is fixed in the external angle facing Safa. It is considered by the Mohammedans as the center of the world.

The structure is not exactly oriented, but this might be called the southeast corner. The history of this heavenly stone, given by Gabriel to Abraham, does not conceal the fact that it was the most venerated of a number of idols which existed in the time of Mohammed. The deep feeling of religious conservatism which has preserved the rude Ka'ba did not interfere with the elaborate ornamentation of the outside. In the time of Mohammed the exterior was covered with a veil of striped cloth, but the caliphs in time substituted the richest brocades. The interior of the Ka'ba is opened only a short time each year. It contains a chest that holds Korans; various articles in silver, as thirteen lamps, also decorate the strange structure. The stone is kissed by multitudes of the faithful during the time of the pilgrimages.

Our engraving, for which we are indebted to L'Illustration, is taken from a photograph made by M. Gervais Courtellemont, and represents the faithful praying before the Ka'ba in the courtyard of the great mosque.

[FROM THE SEATTLE POST-INTELLIGENCER.]

A WINTER VISIT TO MOUNT RAINIER.

THE expedition sent out by the Post-Intelligencer on December 17, to ascertain the nature of the changes on Mount Rainier, the snow-clad sentinel of the Cascades, which towers 15,000 feet above sea level sixty miles southeast of this city, has confirmed the belief that this, the only live volcano in the United States proper, has broken out into unusual activity during the present winter, and thus the expedition, having definitely ascertained this fact, may safely be pronounced a complete success. The observations of the party were minute and accurate, and demonstrated beyond the possibility of a doubt that the mountain has been in a state of eruption, not, however, to the extent of causing the tremendous avalanches which have swept bare the whole north side. It has long been known that Mount Rainier was a smouldering volcano, but that fact does not entirely explain its recent unusual activity. Major E. S. Ingraham, leader of the expedition, is inclined to the belief that the avalanches are in no way the result of the eruption, but are merely due to the great accumulation of new snow, which so increased the burden on the steep, rugged sides of the mountain that the rough surface did not afford a sufficient foothold for the superincumbent mass. There is a very plausible theory, however, connecting the eruption directly with the avalanches, in which the major is inclined to take no stock. While the party were making their way from the north to the east side of the mountain, at an average altitude of 7,000 feet, numerous warm soda springs, gushing from the rugged cliffs and from the banks of ice and snow, were discovered. The waters of the springs, having a temperature of about 60° Fahrenheit, were not frozen, but cut their way to the ground for short distances under the snow and ice, appearing again on the surface of the mountain lower down. It was the theory of some members of the party that the unexplained unusual activity of the mountain had increased the flow of these warm mineral springs to such a volume that the immense accumulation of ice and snow on the precipitous sides of the volcano had become undermined and that the avalanches were the inevitable result.

It will be remembered that Mount Rainier first gave evidence of being in active eruption on November 24 last, when, even from Seattle, thousands of people saw smoke and steam rising from the summit, while to add to the strangeness of the phenomenon the north side of the mountain appeared bare and depressed, as if a tremendous cave-in had occurred. Interest in the disturbance was multiplied a hundredfold about this time by several slight but distinct shocks of earthquake which visited the Puget Sound region, and there were many nervous people who prophesied that this city of 60,000 souls would be destroyed in the same manner as was Pompeii by Vesuvius. The matter became the subject of much newspaper discussion all over the United States, and so grew the interest that on December 10 the Post-Intelligencer decided to send an exploring expedition to ascertain the exact nature of the disturbances and to report the changes which had evidently taken place on the mountain.

As leader of the explorers the paper selected Major E. S. Ingraham, one of the veteran mountain climbers of the State, who had six times previously been up the mountain, and who had also twice ascended Mount Baker and other of the more prominent peaks of the Cascade range. For members of the party the major selected four well known men—E. Coke Hill, George Russell, R. H. Boyd and Dr. L. M. Lessey—while accompanying the expedition was William M. Sheffield, staff correspondent for the Post-Intelligencer, the party being thus composed of six in all. Mr. Hill is a young lawyer of this city, who will be remembered in California during his college days at Berkeley as the champion amateur long distance runner of the Pacific coast. Mr. Russell and Mr. Boyd are members of the Seattle Athletic Club's football team, and are both fine athletes. Dr. Lessey is almost as enthusiastic a mountain climber as Major Ingraham, and has been to the summit of Mount Rainier twice, last summer being a member of the Ingraham party which went to the top and spent a night in the smouldering crater. The personnel of the party thus disposed of, Major Ingraham made elaborate preparations for the comfort of the men in shape of food and clothing, each man being provided with a suit of oiled clothing of a character calculated to shed the rain and protect the wearer from the cold and damp. The route to the mountain was another matter for calm consideration, for, though there are several routes considered feasible in the summer time, a trip had never been attempted in the winter, and with heavy snow and no roads or trails this exertion alone would tell heavily upon the men. It was finally decided to reach the mountain by following the basin of the Carbon River, which necessitated a tramp of twenty-seven miles through trackless forests from the nearest railroad station.

THE DEPARTURE FROM SEATTLE.

The leaving of the party from Seattle was the occasion of much excitement, and many were the expressions of godspeed from the people gathered at the depot, and there were numerous predictions of disaster, for few believed that all, if any, of the explorers would return to civilization alive. The members of the expedition were well equipped with Arctic clothing, scientific instruments, such as aneroid barometers, self-registering thermometers, and cameras, and also with ample provisions, etc., while an important part of the outfit consisted of Canadian snowshoes and a toboggan, the latter to be used for carrying the larger part of the outfit into the mountains. The outer clothing consisted of eight-ounce duck, coated with linseed oil and dried. Heavy woolen underclothing was worn, and the feet were incased in two pairs of heavy woolen socks, with an outer covering of heavy boots, while, when snowshoeing, moccasins were to be worn. From the head to the hips the men were dressed in loose-fitting blouses of oiled material with a hood attachment, the garment being split at the neck to allow the wearer to get in and out of it easily and at the same time allowing no room for the rain and

cold to gain entrance. On the hands were worn heavy woolen mittens, and all the men were provided with alpenstocks to aid in climbing. Thus equipped, the expedition left Seattle at noon, December 17, and the first stop was made at Puyallup, thirty miles distant, where Major Ingraham secured the seven homing pigeons which were to be the party's only means of communicating with the outside world. A stop of a few hours at this place was necessary before the train to the little coal mining town of Wilkeson, from which place the tramp to the mountain was to be commenced, arrived. The party reached Wilkeson, thirty miles away, the same evening after dark, and proceeded to take a good night's rest before the work of the following day.

From Wilkeson east to the Carbon River, eleven miles distant, there is a very good mountain trail, known as the transcontinental trail, over which coal and gold prospectors have for years found their way to the river, up which they made annual excursions in search of fortunes. The trail being sufficiently developed to admit of horses traveling over it, two of these animals were engaged and packed on the morning of the 18th with all they could carry, while the excess luggage, amounting to 180 pounds, was divided among the men and an early start was made.

That morning at Wilkeson can hardly be forgotten by the members of the expedition. The air was crisp and bracing and made all feel fresh and adequate to the undertaking, though none had a very clear perception of what was in store, for never in the history of the State had an expedition of the kind been attempted in the dead of winter. The hardy miners and timid rustics at the little town shook their heads solemnly when the nature of the expedition was explained to them, and when the six men filed over the fir-clad hill above the town, following the rough trail into the mountains, it looked to the onlookers more like a funeral procession than an exploring party. But all were happy and did not propose to cross any rivers until they came to them. The two men who had been employed to attend to the horses had some difficulty in making the animals walk along rapidly, for the trail was at best uneven and hard to travel, and night found the party at Carbon River, having covered a distance of but eleven miles. At this place camp was made for the night and the packers deserted the expedition, alleging that it would be impossible for the horses to go any further up the river. They also volunteered the cheerful information that the men would find the country in such a broken condition that not even they could get over it.

Carbon River is a swift roaring stream and the outlook certainly was unfavorable, especially as the morning was ushered in with rain and a little snow. Camp was broken early, and the six men arranged their packs, seventy pounds to the man, which were carried on the back, much after the manner that soldiers' knapsacks are attached to the shoulders. The major, in addition to his pack, carried the pigeons, which, box and all, weighed thirteen pounds and a half. The old trail followed the windings of the river on the left bank for about three miles and then grew so blind that it could not be traced and the party took to the river bed. It was hard work making progress over the cobble stones and general debris along the route, and it was necessary to ford the river many times—in all twenty-three fordings were made on this day. The river would wind in and out and the men would tramp along until they came to places where the stream ran snug up against a bluff, and then nothing was open but to wade, and in they would go. The water springing from the ice and snow was bitter cold, but after two or three fordings had been made the men did not stand on ceremony, but went right on as though wading in icy water to their waists was an ordinary occurrence in their daily existence. About 3 o'clock the party reached a place where the river narrowed and attained a depth that was over a man's head, and rushed through the close canyon, lined on either side by almost perpendicular mountains. It appeared as though they had reached an impassable point, but Major Ingraham armed himself with a camp ax, and in two hours' time had cut a trail around the bend on the face of the bluff, through the underbrush, of sufficient width to permit the party to proceed to more open territory. About noon on this day the major liberated one of the pigeons with a short message making known the progress of the party up to that time. The bird was liberated from a log in the river bed and almost immediately soared skyward in broad circles until he got his bearings at a height of about 500 feet, and then he darted off in a bee line for home. Subsequent developments showed that this bird arrived home in an hour, going a distance of about forty-three miles.

Inasmuch as it would have been folly for the men to dry themselves after each fording, they did not permit the inconvenience of wet clothing to deter progress, and so kept steadily on the march. Within a few minutes after sunset darkness settled down upon the little band and they found themselves without a camping place, all wet and somewhat disheartened. There was a drizzling rain mixed with snow, and altogether the night was of a nature to make one depressed. Major Ingraham endeavored to locate a dry place on the bottom for a camp and succeeded in doing so, the place selected being amid a clump of tall fir trees on an island. Owing to the darkness it was impossible to find any dry wood, and consequently all were compelled to turn in wet and cold and without any light. The men made their supper off hard tack and bologna sausage, and slept well in spite of the unfavorable conditions under which they had retired. Owing to the many difficulties of travel the party made but six miles during the day. All things considered, however, the day's work was all any one could expect.

At daylight camp was astir and in a short time a dead log of Alaska cedar was found and a fire started, over which a breakfast of rolled oats, ash bread, steak and hot coffee was prepared, and making a hasty pretense of drying out, the men proceeded up the river with light hearts but heavy packs. Before leaving, one of the men cut an inscription in the bark of a cottonwood tree, naming the place "Dismal Camp."

Each day's tramp resembled the other in point of hardship and difficulty encountered in ascending the river. When three miles from Dismal Camp, the party came to the junction of Canada Creek, which reaches the grand canyon of the Carbon River after a series of waterfalls down the sides of precipitous cliffs. It was necessary to ford this stream, and it proved of such depth and great swiftness that two of the party were ducked, each taking a camera to the bottom with him, thus leaving but one uninjured camera in the outfit, and thereafter this one was guarded with great care.

About two miles beyond Canada Creek the party came upon a log cabin built on the side of the bluff on the left bank of the river, and said to be owned by gold prospectors, who have a claim back in the mountain. Here camp was made for the night and it was withal the most comfortable camp of the whole trip. The following day five miles were made, and the party camped that night in a clump of trees about eight miles from the head of the canyon. Here plenty of good, dry wood was found, and all succeeded in getting their clothing and blankets pretty dry before turning in for the night. The following day was December 23, and the men succeeded in getting five miles nearer the goal. When darkness overtook them, they made camp on the bed of the river in a small grove of cottonwood trees, and slept quite well, although the thermometer registered in the vicinity of zero. It snowed a good deal that night, and by morning the snow had reached such a depth that it became necessary to use the snow shoes, and this proved very nearly the hardest day for the party. A great part of the outfit was loaded on the toboggan and three men dragged it over the uneven snow bumps along the river bed, and when fordings were necessary the toboggan was sometimes unloaded and the outfit carried across on the shoulders and then loaded again on the opposite bank.

The delays thus occasioned were vexatious in the extreme and taxed the patience of the men to a great degree. Dr. Lessey and Major Ingraham preceded the party many miles, and when, two hours after sunset, the men dragging the toboggan reached the place selected for the night's camp, they found a fire had been started, and the evening meal about prepared. The day's exertions had produced tremendous appetites, and after supper the men sat around the fire and spent the evening in discussing plans for the following day. Coming up the canyon there was abundant evidence of game, deer, bear, mountain goat and rabbit tracks in all degrees of freshness being seen on every hand in the new snow. But no time was taken for hunting, the party pushing on in their desire to reach the goal. When camp was made on this night it was still snowing and objects a hundred yards away could not be discerned. In fact, owing to the inclemency of the weather, it was only occasionally that it was possible to gain glimpses of the towering cliffs and snow-clad mountains on either side of the canyon. At this time it was known that the party was quite near the Carbon glacier, but just how near could not be ascertained. A supper of hot coffee and beef steak fried on the coals made the hungry men feel that they had enjoyed a repast fit for kings, and the next hour was spent in drying clothing. The wind blew cold that night and chilled all, and it was the first night that any of the party were troubled with sleeplessness on account of the cold.

The morning was ushered in without a cloud, and at daylight the first man astir was the major. He had no sooner poked his head out from under his blanket than he shouted excitedly:

"The mountain! the glacier!"

The whole camp was astir in a moment. Looking to the east, the canyon came to an abrupt termination, and between a rift in the mountains, outlined as delicately as a rent in the clouds, towered Mount Rainier, it seemed almost to the sky. It was a great surprise. The mountain was majestic in all its rugged grandeur, and the men were for a few minutes lost in wonderment. The source of the Carbon River, at the mouth of the carbon glacier, was not over half a mile distant. The Carbon glacier extended from the side of Liberty Cap, the highest peak on the north side of the mountain that is visible from Seattle, downward toward the men at graceful angles until it seemed almost within touch. From the top of Liberty Cap for 5,000 feet downward the mountain is almost perpendicular, presenting a bare, rock-ribbed front off which snow and ice to a depth of 350 to 400 feet has slid, causing the avalanches that have been the subject of so much discussion. At the base of this first great declivity the contour of the mountain broadens and flattens, forming great valleys of eternal snow and ice. On the ragged ridges of this canyon are several clumps of scrubby growths of Arctic trees of evergreen variety, the dark green of the foliage presenting a beautiful and striking contrast to the ice and snow.

From camp it appeared as though the canyons above must be peopled with men and women of another clime, whose knowledge of magnificence and architecture far surpassed in grandeur that of this age on earth. The great ragged, jutting cliffs of white, black, and deep blue ice marking the face of the broad glacier appeared as structures erected by the wise men of Mars or some other advanced planetary people. There was no apparent limit to space; the great white mountain looked as broad as the heavens, and though one might half expect to hear the rush of cars, the noise of great factories, the cries of people, the songs of children marching in gala parade and the singing of happy birds, listening ears were greeted by naught save dead silence.

THE CARBON GLACIER.

It was exceedingly difficult to imagine that what was seen was a part of this earth. Rather it seemed that one was looking through an immense telescope into the very heavens. As the men feasted their eyes on the panorama the sun tinted the snow-capped peak with the prismatic colors of the rainbow, and the white crest of the mountain glistened and shone until the eye became dazzled and the brain grew dizzy. The glacier stretched away from the great city that it appeared must exist in the hollows and glades beneath the frowning precipices, its uneven surface becoming more rugged and broken as the eye followed it in its closer approach. This glistening body of ice and snow comes to an abrupt end at the meeting of two mountains, which are covered with a dense growth of fir, cedar, and pine. It is here that the glacier is checked; it can go no farther. It is also here that the Carbon River finds its supply and is kept flowing with the steady and eternal melting of the glacier. At the point where it is checked by the two mountains the glacier presents an almost perpendicular front of snowy whiteness 300 feet high and 200 yards in width. A little to the right of the center of the face of the glacier is a great cave, the mouth forming an oval, from which the Carbon River bursts in its full force with a rush and a roar.

After the first intoxication of so unexpected a scene the men prepared a hasty morning meal of ham and coffee, for the major informed them that they must eat if they expected to explore the wonders of the great old volcano. Before starting a second pigeon was liberated. Although it began to storm, the bird spent little time in pluming himself, but he did make several ineffectual attempts to pluck the message which had been wired to his tail. In a few moments he soared from view, and it was later ascertained that he arrived home in good condition, bringing the message with him. An early start was secured, and in an hour's time the party were at the foot of the glacier, and two members entered the cave out of which the Carbon River rushes on its way to mingle its clear blue waters with those of the salt sea. The cave is about 100 feet wide, and on one side the roof is arched like that of an ancient cathedral, the room being about 70 feet high, 80 feet wide and 200 feet deep. In the cave the noise of the angry waters as they tumble out of the base of the great stream of ice is deafening, but inspiring. The climb up the face of the glacier was accomplished after an hour's persistent work, and from here a better view of the summit could be obtained. Liberty Cap did not appear over 400 or 500 yards away, but the major assured the party that the snowy whiteness of the mountain sides was deceptive; that the gradually rising glacier was in itself five miles long and the summit of the mountain was fully eight miles away. In all the dead silence of the white, beautiful mountain the solitude seemed strange, for one felt that it would be the most natural place in the universe to find a foreign but great people living above us all, thinking strange things, pondering over wise problems, worshiping the true God—out of touch with the foibles and weaknesses of the lower mankind in general. But there was no sign of life; no sound, save the whistling of keen wind about our half frozen ears.

THE ECHO CLIFFS.

While proceeding up the glacier the men were compelled to wear their snow shoes, for there was about ten feet of newly fallen snow, through which it would have been impossible to navigate without these clumsy but absolutely necessary pedal attachments. About two miles up the glacier, as the men carefully felt their way upward, avoiding crevasses and making their way around cliffs of ice which had been thrown up by avalanches at various times, they found themselves nearer the southern side of the glacier, and when they called to one another it seemed that a hundred voices answered them. They were all a hearty set and little things would not move them, but this phenomenon certainly did surprise, even if it did not disturb them. When one called, his words would be answered several times and continue ringing until the force of the sound died away in the distance. The major, seeing looks of inquiry, calmly announced:

"The Echo Cliffs."

The cliffs are about 700 feet high and half a mile long, and the glacier skirts the rocks closely. The echo from these cliffs is remarkably distinct and clear and very strong, giving a perfect echo of four words.

About noon the top of the mountain directly above became obscured, and, almost without warning, the little party found they had been overtaken by a fierce snow storm and labored to get to the timber line on the left side of the glacier. Though they worked assiduously for four hours, there was no timber in sight, and it was next to impossible to see twenty feet ahead, but the explorers persistently kept going, feeling their way carefully along ledges of ice and avoiding crevasses of unknown depth. The route chosen had an upward tendency all the while, and sometimes the men ascended ridges that went up at angles of 30° to 45°. Almost at dark Dr. Lessey, who happened to be in the lead and had just reached the top of a 500 foot hummock, shouted:

"Timber is below us!"

Reaching his side, the men saw about 500 or 600 feet directly beneath them, at a sharp angle, a little group of fir and pine trees. They did not stand on ceremony, but, sitting on their snow shoes, slid down the side of the hummock and sought the shelter of the trees. It was dark almost immediately and the wind began to howl and blow fiercely. The party soon became chilled to the bone and dug a level place in the snow under the trees and made an effort to shield themselves from the wind. The major found sufficient wood to start a fire, and a brief meal was prepared. Sleep was out of the question, but the men wrapped their blankets around them and endeavored to imagine they were in burning hotels, or other nice warm places, thus hoping to delude their shivering selves into the belief that they were not freezing to death, but were quite comfortable. Two members of the party suffered intensely from the cold, and one of the boys shivered and chattered to such a remarkable degree that the gold filling out of one of his teeth was rattled out. Boyd, the largest member of the party, who stands six feet six inches tall and weighs 225 pounds, while strong and willing, and a good companion, felt the cold more keenly than did any of the rest, and inasmuch as he had been familiarly called the Congo giant, on account of his size, this place was by common consent named "Camp of the Congo's Shivers." During that first night on the mountain there were many things to keep a man awake besides the cold. The men believed they were the only living things in all the space about them, but for over two hours the howling of a solitary half-frozen timber wolf kept them company and added to their peace of mind, while in the distance the rush and crush of avalanches coming down the precipitous sides of the mountain could be distinctly heard.

Happiness reigned when the day broke, for with the rising of the sun the clouds disappeared and likewise the falling snow, and everything stood out with remarkable clearness. It was then discovered that the camping place of the night was on a glacial

island and the little clump of trees in which the party had taken refuge was the only timber to that height within 500 feet. The altitude of the Camp of the Congo's Shivers is 5,500 feet. As soon as possible the men got their outfit together and started on their way to the mountain proper. When they rounded the hummock of the glacier and came in view of the mountain, they could see more plainly where the mighty avalanches had come down, which were in reality the cause of the changes in the contour of the north side of Mount Rainier. The north side of the mountain was bare and the rough canyons coursing down the sides of the old sentinel appeared vastly deeper and had additional grotesqueness, inasmuch as they literally stood on end, being almost perpendicular.

It did not occur to the climbers at first that it was Christmas eve. They were too much interested in the scene above them to think of ordinary earthly things, and there was not a man of them who had a thought for Santa Claus or what he was doing for those below. At noon on this day the party had succeeded in crossing the glacier and reaching the head of Pleasant Valley, where another homing pigeon was released. This bird, it was afterward learned, was several hours reaching its destination and arrived at its loft with its tail feathers all gone and the message missing. It was evident that the pigeon had had an encounter with a hawk or an owl, or some other bird of prey.

Pleasant Valley was so named on the occasion of a visit in the summer time. At that season of the year it is a beautiful glade, covered with strange wild flowers, which push their heads through the snow and have white and blue blossoms the size of one's hand. In the winter time it is anything but a pleasant valley, for the snow is of great depth and the wind whistles and howls through its entire length, making it a good place for a man to avoid. The ridge dividing Carbon glacier from Pleasant Valley is about 1,000 feet in height. It is reached by a climb of about 800 feet in snow to one's shoulders, up an incline of 40°. On this ridge is quite a growth of scrubby evergreen trees, and here the shotgun and rifle taken along, proving too heavy to carry, were cached in the snow. The men proceeded across the Elysian Fields and then entered upon a vast strip of snow fields, walking a distance of five miles, all the while going around the mountain from north to east, keeping an upward angle, thus making the course a spiral one. On this afternoon's tramp a timber wolf, having evidently seen the hiding of the rifle and shotgun and knowing there were no firearms in the party, followed closely, crossing and recrossing the route but keeping always out of sight. At 4 o'clock in the afternoon, as the party rounded a ledge of snow-capped rocks, the major looked at the mountain towering directly above and cried:

"See the smoke! See the steam!"

As all eyes were turned upward, geysers of steam several hundred feet high shot upward until they became dissipated in the air and then their places were taken by others, some larger and of greater volume, and some smaller. The steam came from the big crater and the smoke from the smaller one. The smoke came out in puffs as if from a locomotive smokestack, and rising in the air continued to ascend far above the steam, until absorbed by the atmosphere. The climbers gazed at the strange spectacle for fully ten minutes, until they grew so cold that they were compelled to move on. Major Ingraham said he had been on the mountain six times previously, but had never seen geysers of steam, much less smoke, issue therefrom, and would not have believed the mountain in active eruption had he not seen it with his own eyes. He declared the sight was a revelation to him. Smoke and steam were noticed many times that same evening as the party marched along on their way to Winthrop glacier. It was about 3:30 o'clock in the afternoon when they reached a snowy bluff overlooking this glacier, directly on the opposite side of which appeared a ragged line of cliffs with a slight depression toward the upper end, which is known as St. Elmo's Pass—the objective point of the expedition. It was the intention to cross the glacier, go through St. Elmo's Pass into Interglacier and then proceed to Blaine glacier, up which the route to the summit was to be investigated.

The glacier was greatly broken up by cliffs of ice and yawning crevasses of unknown depth, and Major Ingraham announced that it would require at least two hours of continuous hard travel to cross it. Once across, the only safe place to spend the night would be on the barren ridge on which St. Elmo's Pass is located. There the wind blows with great velocity, and he did not think it a very desirable place to spend the night, for sleep would be out of the question. They would have to dance about all night to keep from freezing to death. After studying the condition of affairs a moment, and the men turning their eyes upward again, watching the steaming and smoking mountain above, which seemed always within reach, but ever distant, the major gave the order to make camp. Making camp was no easy thing at this time, for the men were now 7,000 feet above sea level and 1,500 feet above the nearest timber, and the prospect of a night in the ice and snow was not at all inviting, especially as the cutting wind was even now catching up the light frozen snow and whipping it about the men's chilled bodies. About 500 feet above, reached by a sloping wall of snow necessitating a climb at an angle of 40°, was an immense, rugged rock. The banking of snow on its east side demonstrated to the keen eye of the major that it would be a desirable place to make camp, for there the men would be in a measure protected from the winds. An ascent to the rock was made without any great fatigue, and to the great joy of all it was discovered that from the solid rock burst a small, rippling stream of warm mineral water, with a temperature of about 60°—the water being the only unfrozen thing in all that vast district. All were thirsty, for the snow was so light that it had hardly any noticeable moisture, and they drank deeply from a tiny waterfall.

A large cave was then dug in the drifted snow at the base of the rock with snow shoes and alpenstocks, and here the adventurers proceeded to spend their night before Christmas. The major had provided himself before leaving Seattle with a spirit lamp made of tin, and filling it with alcohol from a canteen carried by one of the party, he endeavored to make a pot of coffee, but the rarity of the air and the intense cold, together with the breaths of icy wind which found their way to the cave, made the experiment impossible. After half an hour's patient attention the water had only reached a lukewarm state, and emptying a can of condensed milk into the coffee pot the men dined off hard tack, warm milk and seedless raisins. Such a meal is not so bad as one would imagine. The men enjoyed it immensely, and voted the major a genius of the first rank. From this place, which was unanimously named "Camp Ingraham," the view of the surrounding country was simply grand.

To the north the vision extended for 200 miles, or until the earth kissed the horizon. Mount Baker was visible for a distance far below the snow line, while the peaks of Mount Garfield and Mount Shuksan, and other mountains were remarkably clear and seemed but a short distance away. To the east the lesser peaks of the Cascade range were enveloped in clouds, and to the west the deep blue waters of the Sound could be traced, winding out and in through the landscape like a delicate ribbon. The Olympics, which could be traced their entire length from the southern extremity to where they sank into the ocean at Cape Flattery, looked wonderfully small, but were outlined clear and distinct. The Sound cities could not be distinguished because of the great distance, but it may be their exact localities were obscured by the patches of clouds which persisted in settling down on the regions not favored by an altitude so high as that of Camp Ingraham.

It was like a cold, cutting night at sea, and the men in the snow cave on the mountain side were the officers in the open cabin of a brave vessel. The men stood in the cave, the snow at the outer edge reaching to their breasts like a bulwark, and they whipped their arms around their bodies, danced and pulled their caps down tighter over their ears in their endeavor to keep warm, for they could not resist the temptation to brave the elements and take in the view before them. For the time being they heeded not the cold, and, filling their lungs with the fresh, pure air, they felt supreme, delighted, and intoxicated by the splendor of the scene.

(To be continued.)

LAND TENURE IN TUSCANY.

IN these days of socialism, anarchy, and almost universal agricultural depression, a sketch of the patriarchal co operative system of farming prevailing in Tuscany may be found interesting. Old fashioned it certainly is; the Marquis Gino Capponi, one of the most strenuous advocates of mezzeria, or half and half land tenure, traces it back to the Romans. "Instituted," he says, "in the palmy days of the republic, when the plebians obtained civil rights, it fell into disuse on slavery becoming general." In the fourteenth century, when the castles of so many lordlings were razed and their power broken, mezzeria was almost universally adopted in Tuscany. None can deny that it is a bar to modern improvements and to high farming; but socialism has no hold on the agricultural population where it exists, and the land, not being burdened by the middleman, has hitherto supported both proprietor and peasant. Theoretically, mezzeria is the equal division between the owner of the land and the peasant who tills it of all crops gathered from the soil. They are partners in the business of farming; one contributes capital, the other labor. In reality the peasant has the best of the bargain, and several authorities on agricultural questions will tell you that the system must be modified or cease to exist. In the good old days of light taxation it answered admirably; but now that the unfortunate landowner pays a third or more of his net moiety to government, he has little left to live upon or to spend in improvements. A farm (podere) ranges, generally speaking, from eight to thirty acres, regulated very much according to the numerical strength of the peasant's family. Each farm has a house with stables and outbuildings, for which the peasant pays no rent, and which are kept in repair by the landlord. The latter provides capital for buying oxen, cows, horses, or donkeys, and all gain or loss on the animals is divided between him and the peasant. Accounts are kept by the proprietor or his factor; and every month the head man (capoccio) of each peasant family brings his book to be written up and the money he has encashed for milk, vegetables, fruit, and other minor products.

In Tuscany you will often find peasants whose families have been on the same farm for two or three hundred years. They talk of themselves as gente (the Roman gens) of the padrone (landlord), and take an affectionate interest in him and his family. But the Tuscan peasant is a thorough conservative; he has not yet grasped the changes brought about by railroads, steamboats, and international communication. The late Marquis Gino Capponi, in a paper read in 1833 at a meeting of the Royal Academy of Georgofili in Florence, said: "The Florentine landowner, who originally sprang from the people and was always by the very nature of the government most desirous to keep well with them, was not, and could not be, a tyrannical master. Some writers have asserted that the so-called patti colonici are a remnant of feudalism. But whoso examines the nature of these patti will see that they are a compensation for what the contadino takes from the land in addition to his lawful half share—a kind of rent for the minor products which cannot be divided"—that is, vegetables, fruit, milk, etc., consumed by the peasant and his family which are never taken into account. Some years later, in 1855, the late Marquis Cosimo Ridolfi, a well-known authority on agriculture, condemned mezzeria, praised in such eloquent and glowing terms by M. de Sismondi, and, contrasting the yield per acre of land in England with that in Tuscany, advocated a return to la grande culture. Signor Lambruschini unhesitatingly took up the defense of the half and half tenure, pointing out that the day laborer having no interest in, or love for, the land he cultivates, begins and leaves off work at stated hours and cares little or nothing for the success of the crops. If mezzeria is abolished, Signor Lambruschini continues: "All these families who, though poor, have a roof they can call their own, a field they can call theirs, who have a master they love and bless, and who, toiling and watching under rain and sun, hope and pray to God for abundant crops for themselves and for their master; all these, I say, will for the first time feel the pangs of envy and hatred, the shame and despair of being forced to beg and to wait for work. We at the same time shall learn to dread meetings and strikes such as we see in France and in England, the destruction of agricultural machines, the burning of ricks, barefaced robbery and—as the last and miserable remedy—the poor tax."

By old established custom the landlord helps the peasant if by reason of illness or a bad harvest he should be in straits. There is between them what may be called an account current without interest. Sometimes a peasant leaves several hundreds, or even thousands, of francs in the landlord's hands; sometimes he is in debt, and this is paid off in kind as the various crops come in.—Macmillan's Magazine.

THE WOMEN OF MOROCCO.

By J. E. BUDGETT MEAKIN.

OF no country in the world can it more truly be said that the social condition of its people may be measured by that of its women than of the empire of Morocco. Holding its women in an absolute subjection, the Moorish nation is itself held in subjection, morally, politically, socially. Of the Moors it may indeed be recorded that every man's hand is against his neighbor, and all men are against the women. "Teach not thy daughter letters, nor permit her to live on the roof"—or, in other words, to enjoy the smallest liberty—is a native proverb embodying the universal treatment of the weaker sex. It is the subservient position of woman which strikes the visitor from Europe more than all the oriental strangeness of the local customs or the local art and color. Advocates of the restriction of the rights of women in our own land and of the imposition of disabilities unknown to men, who fail to recognize the justness and invariability of the principle of absolute equality in rights and liberty between the sexes, should investigate the state of things existing in Morocco, where the natural results of a fallacious principle have had free course.

No welcome awaits the infant daughter, and few care to bear the evil news to the father, who will be sometimes left in doubt as to the sex of his child till the time comes to name her. One of the most commendable traits in the Moorish character is the love expressed by the fathers for their boys, but this is seldom extended, at all events in public, to their daughters. Otherwise, however, the lot of brother and sister is pretty much the same till the time comes for the little lad to go to school, when forever their ways diverge, since it is very rarely that girls are taught to read. Here and there a father who ranks in Morocco as scholarly takes the trouble to teach his children at home, including his daughters in the class, but this is very seldom the case. Only those women succeed in obtaining even an average education in whom a thirst for knowledge is combined with opportunities in every way exceptional.

The one ideal held before the girl is marriage, and of marriage the least noble side. Of companionship in wedlock the Moor has no conception, and his ideas of love are but those of lust. Though matrimony is considered by the Muslim doctors "Half of Islam," its value in their eyes is purely as a legalization of license by the substitution of polygamy for polyandry. Slavishly bound to the observance of wearisome customs, immured in a windowless house with only the roof for a promenade, seldom permitted outside the door, and then most carefully wrapped in a blanket till quite unrecognizable, the life of a Moorish woman, from the time she has first been caught admiring herself in a mirror, is that of a bird encaged. Lest she might grow content with such a lot, she has before her eyes from infancy the jealousies and rivalries of her father's wives and concubines, and is early initiated into the disgusting and unutterable arts and practices employed to gain the favor of their lord. Her one thought from childhood is man, and distance lends enchantment. A word, the interchange of a look with a man, is more sought for by the Moorish maiden than all the sighs and glances of the Spaniard's coy brunette. Nothing short of the unexpurgated Arabian Nights' Entertainments can convey an adequate idea of what goes on within those whited sepulchers, the broad blank walls of Moorish towns. A word with the mason who comes to repair the roof, or even a peep at the men at work on the building over the way, on account of whose presence the roof promenade is forbidden, is eagerly related and expatiated on. In short, all the training a Moorish woman receives is sensual, a training which of itself necessitates most rigorous though often unavailing seclusion.

Both in town and country intrigues are common, but intrigues which have not even the excuse of the blindness of love, whose only motive is animal passion. The husband who on returning home finds a pair of red slippers before the door of his wife's apartment is bound to understand thereby that somebody else's wife or daughter is within, and he dare not approach. If he has his suspicions, all he can do is to bide his time and follow the visitor home, if the route lies through the streets, or dispatch a faithful slave girl or jealous concubine on a like errand if the way selected be over the roof tops. Except to pay such visits, few of the upper class women ever get out beyond occasional Friday excursons with myrtle branches to the cemeteries, though those who have not the convenience at home get also to the steam bath periodically, and none of these opportunities are lost. In the country, under a very different set of conventionalities, the same sort of thing takes place in other ways.

The lot of a Moorish girl depends almost entirely on her face, for a reputation for beauty, circulated on commission by the female peddlers, may secure her a place in the richest harem in town, if not in that of the Sultan. If plain, she is thought of small account, and in any case, unless her parents are wealthy and own sufficient slaves, she has to share the drudgery of housework with her mother. The number of children in Moorish homes is remarkably small in proportion to the number of wives, and infant mortality is very high. With the youngsters scantily tended, and usually left to roll on the wet tiles of the courtyard naked from the waist downward, it is indeed a case of the survival of the fittest till they have taught themselves to walk. Long before that they have learned that screaming does not pay, and have discreetly given up that exercise of lung which often

makes our English homes resemble pandemoniums. Playing in the courtyard, it is often hard to tell the boys from the girls, so alike is their dress, from fear of the "evil eye," and no one dare take special notice of them or pat them for fear of incurring responsibility should evil ensue. At last the little brother, still in petticoats, has his head shaved bare and goes off to school, the distinguishing feature of his sister being her remaining shock of hair stained red with Egyptian privet, which also adorns her finger and toe nails. Her eyes are blackened with antimony, and later her cheeks are rouged, her chin tattooed, and the gums which support her pearly teeth stained yellow with juice from the frayed stick of walnut root which serves as tooth brush.

At the age of twelve or thereabout she is fattened for marriage by being "crammed" after every meal with pellets of parched flour and honey or sesame seed in oil, and so forth. Arrived at an appropriate rotundity, her father or nearest male relative concludes a bargain for her with some youth unknown to her, and her mother prepares for the wedding. This is the happiest time of her life, as she stands on the threshold so long awaited and dreamed of; but oh, how sadly disappointing! After a tedious round of cooking, bathing, dressing, perfuming and painting, and after sitting statue-like and speechless amid the din of female callers and ear-splitting music for several days, she at length finds her place in the bridal box in which she is conveyed to her new home, there to receive her new lord's first visit and to see what he is really like.

If she be not found a virgin, he may send her home next day with ignominy, but even then her charms may be sufficiently persuasive, or the fear of her family's enmity may act as a restraint. If all is well, now is the time for the firing of guns and the jollification, with which the nuptial ceremonies end. For a year the bride is confined to her home by etiquette, and sometimes her "home" is one room in a courtyard common to three or four families. When a widow is remarried, the thing is done quietly, and no one hears about it. Now she becomes, as the native proverb has it, "A slave by day, a queen by night," till she cedes her foremost place to a second wife or female slave, for four of the former and any number of the latter are permitted to the followers of Mohammed. Then succeed the saddest features of Moorish social life, the frequent attempts to poison one another, and experiments with every sort of reputed aphrodisiac or charm to secure the husband's affections. The tale of all that goes on is too sad, too revolting, to tell—it is almost beyond belief. The desire for offspring is so great that Europeans are constantly pestered for drugs of every imaginable power, and the most absurd expedients are resorted to in vain. In childbirth the Moorish women are decidedly hardy, but the worse than crude notions indulged in by the "wise women" called in to assist on such occasions must be held accountable for serious loss of life. The children of wives and concubines most justly rank side by side in legal status and inheritance, while the concubines, black or white, though remaining slaves till their master's death, may never be sold, and then become free. The mother of the present Sultan of Morocco was one of these, a Circassian imported from Constantinople, and presented to his father by a wealthy governor, very well known to the writer.

The women of the rich employ their leisure time in dressing and painting themselves, embroidering cotton with silk in beautiful geometrical patterns, the same on both sides, to cover pillows, or serve as curtains, etc. The poor have plenty to do in housekeeping, though the marketing is done by the husbands, who seldom trust them with money. It is not an uncommon practice for a husband who wishes to travel to have an iron grating fixed across the courtyard area, to firmly lock and bolt the roof and front doors, and to take the keys with him, leaving funds in charge of an employe, usually a trusted and elderly slave, to supply provisions daily through a turntable in the wall, so constructed that none can see through. Thus he may safely leave home for several months.

The legal expression employed for the nuptial tie is one which conveys the idea of the purchase of a field, to be put to what use the owner will, according him complete control. This idea is borne out to the full, and henceforward the woman lives for her lord, with no thought of independence or self-assertion. If he is poor, all work that seems too hard for him that is not considered unwomanly falls to her share, hewing of wood and drawing of water, grinding of corn and making of bread, weaving and washing, but, strange to say, little sewing. When decidedly passe, she saves him a donkey in carrying wood and charcoal and grass to market, often bent nearly double under a load which she cannot lift, which has to be bound on her back. Her feet are bare, but her sturdy legs are at times incased in leather to ward off the wayside thorns. No longer jealously covered, she and her unmarried daughters trudge for many weary miles at dawn, her decidedly better-off half and a son or two riding the family mule. From this it is but a short step to helping the cow or donkey draw the plow, and this step is sometimes taken.

Until a woman's good looks have entirely disappeared, which occurs as a rule about the time that they become grandmothers—toward thirty—intercourse of any sort with men other than her relatives of the first degree is strictly prohibited, and no one dare salute a woman in the street, even if her attendant or mount shows her to be a privileged relative. The slightest recognition of a man out of doors—or indeed anywhere—would be to proclaim herself one of that degraded outcast class as common in Moorish towns as in Europe. These are known by some outward sign, by the style of the shoes, or the "heightening of the forehead" (by wearing a pad underneath the enveloping blanket), or most effectively of all, by the use of the eye. As a result of the untrammeled sensuality indulged in, the national diseases are of the most loathsome class, and one cannot walk the streets an hour without confronting some awful case of skin disease as foul as leprosy, if not that dread complaint itself.

Readers of the Koran, with no intimate practical acquaintance with the working out in real life of the laws there laid down, except perhaps in some home in Bombay or Constantinople, revolutionized by modern and Christian influence, often entertain the idea that in Mohammedan countries the individual rights of women are well protected, but this is very far from the case, at all events in Barbary. To begin with, the womenfolk are studiously kept in ignorance of all the wise prescriptions there laid down; and of their theoretical rights and privileges in practice they know nothing. Even to obtain a divorce is well nigh an impossibility, and seldom heard of on the wife's petition, though the husband can discharge his wife by nothing beyond a verbal command to her to go, on payment of the sum stipulated in the marriage settlement, if he has not already advanced this under some pretext or other, and had the benefit of it himself. Rich men frequently marry poor girls because of the ease with which they can get rid of them without having to fear their relatives. Once so divorced, a woman may be taken back again, and be dismissed a second time, but after the third divorce, or the fulmination of a triple divorce at once, she must be married to another and divorced by him before the first husband can take her back.

Bribery and influence determines the operation of the somewhat intricate laws as to her personal property and the provision for her children, left after infancy in the custody of the father, who ought to provide for them all along. The theoretical legal status of Moorish women is that of the Koran, though so many methods of evading the provisions of the law are known that their "rights" are of small concern to them. Of course there have been, and are, exceptional women, whose individuality has raised them far above all others around them, but such are few and far between. But a girl whose good looks, advocated by her father's presents to Wazeers and superintending "wise women," have secured her admission to the royal harem, may, if she become the mother of a prince, rule the seeming autocrat. Those who fail to find favor are bestowed on country governors when paying their respects at court.

Such is the sad lot of women in Morocco. Religion itself is all but denied them in practice, whatever precept provides, and it is with blank astonishment that the majority of them hear the message of those noble sisters of theirs who have devoted their lives to showing them a better way. The greatest difficulty is experienced in arousing in them any sense of individuality, any feeling of personal responsibility, or any aspiration after good. They are so accustomed to be treated as cattle that their higher powers are altogether dormant, and all possibilities of character repressed. The welfare of their souls is supposed to be assured by union with a Muslim, and few know even how to pray. Instead of religion, their minds are saturated with the grossest superstition, in itself a subject worthy of a special study. This is the condition of the free woman; how much worse is that of the slave cannot here be told. Nor need the effect of such a treatment of the mothers of the nation be expressed in detail. The present socially degraded state in which the people live, and their apparent, though not real, incapacity for progress and development, is to a very great extent the curse entailed by this brutalization of its women. No race can ever rise above the level of its weaker sex, and till Morocco learns this lesson it will never rise.—The Humanitarian.

SULPHATE OF IRON AS A MANURE FOR POTATOES.

By E. WIGHTMAN BELL, F.C.S.

THE use of sulphate of iron as a manure for certain crops has been advocated by several chemists, more especially by Dr. A. B. Griffiths, who has published many very satisfactory results from its use, particularly in the case of beans, turnips, potatoes, and clover. This opinion has, as a rule, been confirmed. Still, it was thought that further experiment on the subject might be useful.

The tables given below show the result of the addition of iron sulphate to other manures commonly used with potatoes. Each plot measured one-thirtieth of an acre, and, as far as possible, under similar conditions as to weather, aspect, and composition of the soil (i. e., all were in the same field). My thanks are due to Mr. T. Clayton, Spalding Marsh, for kindly allowing me to make the experiments on his land.

The soil is a rather heavy silt, and contains 4·54 per cent. organic matter, 0·20 per cent. phosphoric acid, and 4·22 per cent. ferric oxide (only a very small quantity of which, however, is in a readily soluble condition).

The previous cropping was two years' clover, the first crop being mown and the second eaten off by sheep each year. The clover was sown with wheat, which succeeded oats after mangolds. The whole of the plots were planted on the same day (April 4), and in very dry weather, and each received the same quantity of potatoes, which were "The Bruce."

TABLE I.

PHOSPHATES WITH AND WITHOUT IRON SULPHATE.

No.	Manure per Acre.	Yield per Acre.
1	3 cwt. mineral superphosphate....	9 tons 11 cwt.
2	The same, with ½ cwt. iron sulphate....................	11 tons 0 cwt.

The above shows an increase at the rate of 1 ton 9 cwt. per acre from the use of the iron salt.

TABLE II.

PHOSPHATES AND SULPHATE OF AMMONIA WITH AND WITHOUT IRON.

No.	Manure per Acre.	Yield per Acre.
3	3 cwt. mineral superphosphate and 1 cwt. ammonium sulphate.....	10 tons 12 cwt.
4	The same with ½ cwt. iron sulphate.....................	11 tons 7 cwt.

Showing an increase at the rate of 15 cwt. per acre on the plot manured with iron, which more than fifteen times repays the outlay on the iron salt.

According to analyses by Dr. Griffiths of the ashes of potatoes grown with and without sulphate of iron, it would appear that iron has the power of replacing potash in plants so treated. The composition of the ash of the crops of potatoes was not ascertained, but it was found that kainit and superphosphate did not give as large a yield of tubers as super. and iron sulphate.

Plot 5, 3 cwt. mineral superphosphate and 1 cwt. kainit, yielded 8 tons 16 cwt.

In this case the addition of kainit has decreased the yield by super. only, by 15 cwt. (vide plot 1), and is 2 tons 4 cwt. less than plot 2. The reason for this diminished yield is not yet ascertained, but may probably be due to excess of saline matter, as it was found that the addition of either ammonium sulphate or iron sulphate further lowered the yield.

From the above results it seems that ferrous sulphate has a decidedly beneficial action on potatoes when used in conjunction with phosphates and ammonia.—Chemical News.

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